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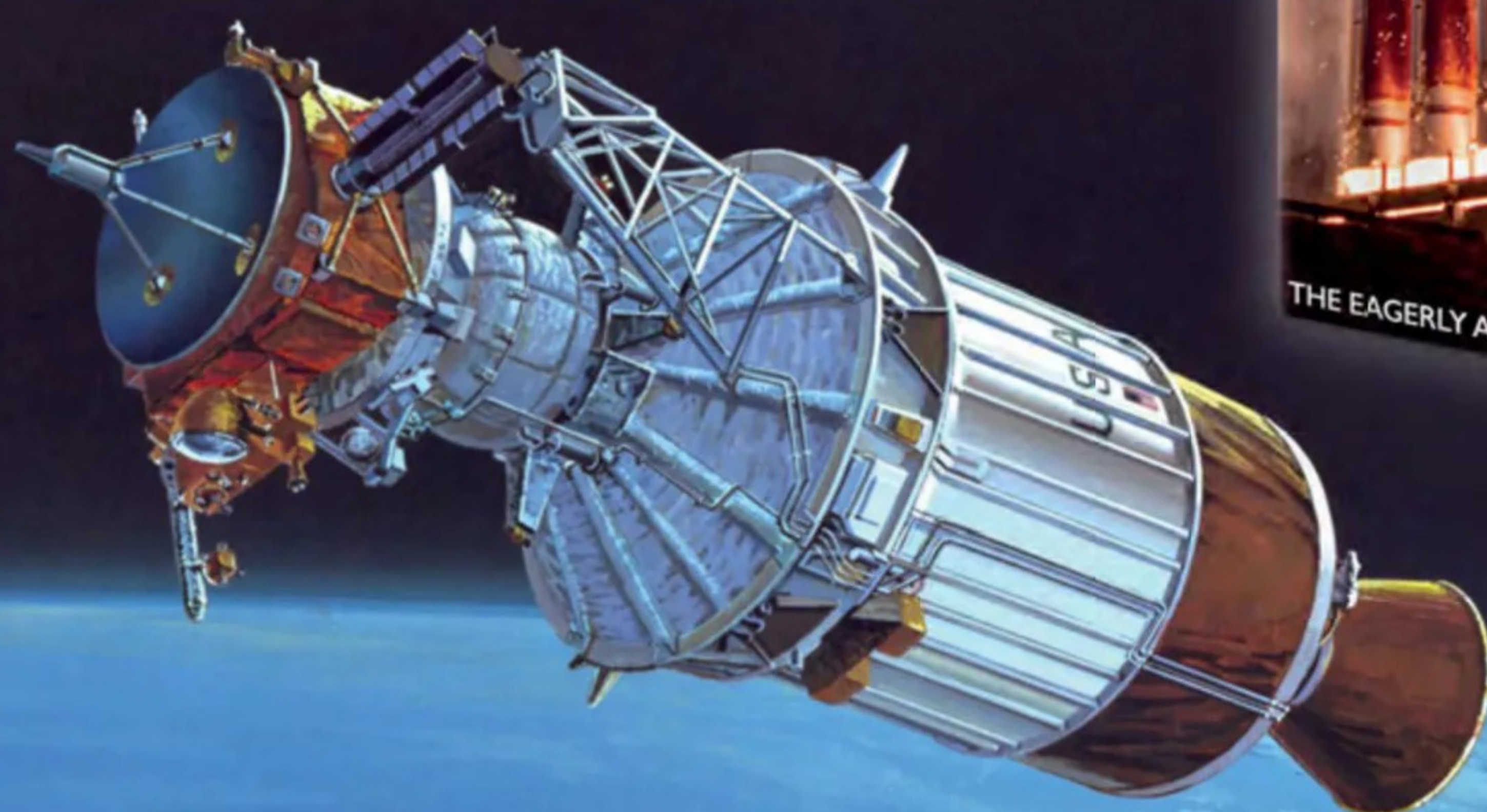
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Welcome

The threat of war in Europe never looked greater, perhaps not since the Berlin Crisis in 1961, although at least then, there were clearly defined boundaries between the East and

West. Now, things are very different, and the talk across the broader media of an ‘existential threat’ and a ‘state-on-state’ conflict in Europe in the 21st century’ appears to be rapidly approaching.

In late January, senior military leaders and government officials with military backgrounds changed their rhetoric, implying that ‘bad things may be coming’.

With Russia still occupying a fifth of Ukraine and the war remaining static along defined lines at present, the potential for Russia to strike out at NATO to achieve an advantage has actively been discussed on open-source military channels. So, what’s the solution?

Supplying arms to Ukraine is continuing after it looked for a while that specific NATO members were becoming war-weary, which had the dangerous knock-on effect of limiting ammunition on Ukraine’s frontlines. Then came the announcement by France that it is supplying 50 of its AASM high-precision air-dropped bombs, known as the HAMMER by NATO, to Ukraine each month until the end of 2024. In addition, French Defence Minister Sébastien Lecornu confirmed that at least 40 more SCALP-EG cruise missiles would be heading to Ukraine, along with an increase in the delivery of 155mm artillery shells from 2,000 to 3,000 per month. Lecornu stated: “We managed to adapt them for use with Soviet model aircraft... we will supply 50 of them [HAMMERS] monthly, starting in January, throughout 2024.”

Safran, the manufacturer of HAMMER, has already integrated the bomb into a version of the F-16, but these are not anticipated to be combat-ready until early 2025.

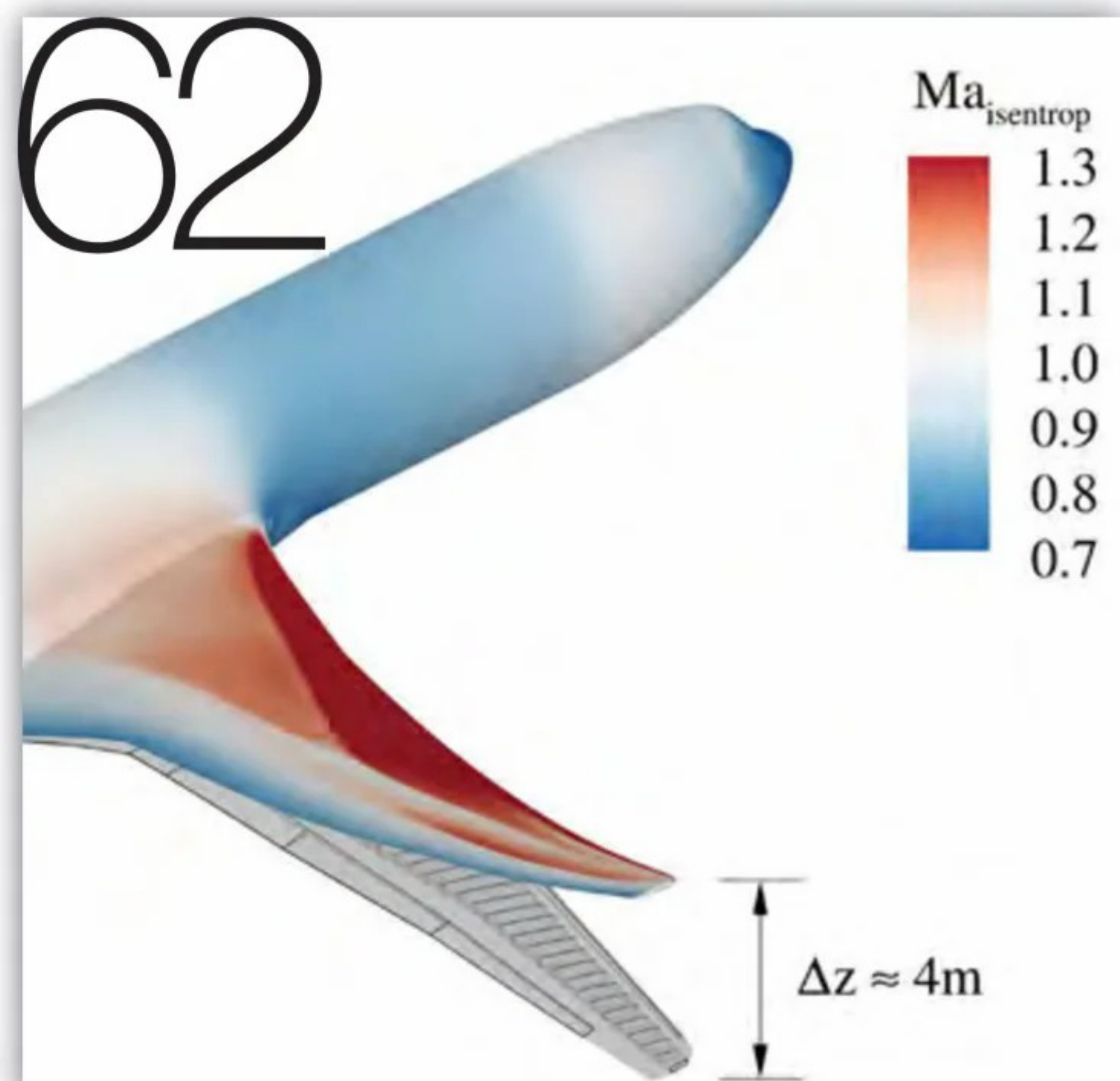
Adding further pressure on Russia is NATO’s largest exercise since the Cold War, Steadfast Defender, which involves 90,000 troops from the ground, naval and air forces of 32 allied countries. It’s a message to Putin and Russia, but one of a number that has had little impact, as with many others.



Glenn Sands
Editor

LEFT:
France has announced it will supply 50 AASM HAMMER precision-guided bombs to Ukraine every month to use for long-range strikes Safran

FRONT COVER:
From basic through to advanced training of military pilots, the M-345 can do it all Leonardo



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often be a chaotic and painful experience for passengers. Alex Preston looks at some of the attempts to improve the process

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Quietly innova



After a three-month test program, the USAF completed a series of assessments on an electric aircraft, culminating in a simulated casualty evacuation exercise with the 41st Rescue Squadron at Moody AFB, Georgia.

The evaluation is part of the Air Force's broader three-year study looking at transformation vertical lift programs called Agility Prime, which is seeking partnerships with OEMs from the commercial eVTOL industry to introduce a new class of air mobility systems to the service, which it views as part of the third revolution in aerospace.

The USAF is keen to adopt these innovations. Air Combat Command leads the charge in this approach, seeking new ground-breaking ways to recover personnel by tapping into the latest commercial eVTOL designs out there.

Beta Technologies is one of the companies selected to partner with the USAF's Agility Prime program. The company developed the Alia CTOL (conventional take-off and landing) to establish a viable platform in the commercial, cargo, industrial,

medical, and military sectors, as opposed to the urban air taxi environment, which most eVTOL companies focus on.

With a range of 250 miles at a speed of 150mph on a single battery charge, the Alia CTOL uses a series of dedicated motors consisting of a rear pusher prop, optimised for long-range, combined with four upward-facing propellers for upward lift. It removes the complex, bulky weight of a tilt-engine thrust vectoring design. Beta intends commercial service entry of the Alia CTOL in 2025, followed by the eVTOL variant in 2026.

Beta Technologies has focused on keeping the design as simple as possible throughout its development and flight test phase, which may have attracted the USAF to the manufacturer.

Currently, the USAF is considering dozens of potential uses for eVTOLs, from rapidly transporting cargo or passengers around their larger bases to combat search and rescue. The service is quickly realising that the benefits of a much quieter, non-fuel-burning helicopter will cost far less to operate and maintain.

The three-month evaluation program was conducted at Duke Field, ten miles north of Eglin AFB, by the 413th Flight Test Squadron and AFWERX, the USAF's development

and innovation section, which is actively looking across academia, industry, and government to develop technology, expand talent and transition dual-use capabilities into the service. As part of this move, USAF engineers and pilots are embedded with several companies for a short period to thoroughly evaluate and, where possible, bring the capabilities and resources of the service to the OEM to develop an affordable transition to flight status, such as been the case with Beta Technologies.

Critical to introducing eVTOLs into the USAF is the ability to charge the platform quickly; in support of the Agility Prime program, Beta installed a Level Three supercharging station at Duke Field, the first such example to be installed at a Department of Defense facility, capable of charging the Alia CTOL in under an hour.

During the evaluation, a number of USAF pilots were converted onto the Alia CTOL and flew in the final simulated exercise at Moody AFB. The casualty recovery mission focussed on a patient operating with a quick-reaction ground unit forward of friendly lines. An HH-60W Jolly Green II transported the casualty from a forward operating base (FOB) to a location in friendly territory; after that, the Alia transferred the



patient to a simulated medical location to provide a more in-depth level of care. According to a Beta Technologies representative, such a mission would usually involve a C-130 Hercules with five to six crew in the latter transfer at a cost of US\$1,600 in fuel. The Alia completed the task with a crew of two for \$5 in electricity.

Additional roles conducted by the Alia CTOL included a simulated maintenance recovery team mission on behalf of the USAF's F-35 Lightning II fleet, where the Alia flew to Tyndall AFB, Florida, to collect a fighter spare part and bring it back to Duke Field. The process proved far quicker and cheaper than using a truck which the service currently does. Other missions included flight support operations, maintenance support, and several infrared signature evaluation sorties.

A platform such as Alia's ability to provide a faster response time could enable same-day maintenance and reduce aircraft downtime. This, in turn, would remove the need for the US DoD or USAF to endure the cost of the associated road transport needed to fix an aircraft.

With the conclusion of the first deployment of the Alia CTOL with the USAF, Beta Technologies is now focussing on the next



stage of Alia's development and increasing the platform's flight envelope.

The potential of the Alia beyond that of the Department of Defense has been demonstrated in the number of significant orders placed for the aircraft, which include UPS, which has ordered ten and reserved 140 more; international lessor LCI, 50 ordered and 75 reserved; and Bristow, ordered five and reserved 50. The latter order is significant, with Bristow heavily involved in offshore support, which will be a first for an electric aircraft. **AI**

CLOCKWISE FROM MAIN IMAGE:

The all-electric Alia has flown 386 miles on a single charge, has a carrying capacity of 1,250lb, and its cruise speed is around 100kts

Images all via Beta Technologies

Beta Technologies completed a test flight of Alia's eVTOL aircraft at Westchester County Airport in White Plains, New York in February 2023

Beta is one of the few eVTOL manufacturers developing its charging stations globally. So far, the company has systems in use at 14 sites on the East and Gulf coasts

Breathing fire

DragonFire, Britain's first laser-directed energy weapon system (LDEW), has successfully been tested against aerial targets during a trial at the MOD's Hebrides

Range, according to a Defence Science and Technology (Dstl) statement, which released details on January 19.

The latest trial, delivered by Dstl and the DragonFire partners – MBDA, Leonardo and QinetiQ – follows on from a series of successful trials, including the first static high-power laser firing of a sovereign UK capability and demonstration of the DragonFire system's ability to track moving air and sea targets with very high accuracy at long range.

DragonFire is the result of a £100 million joint investment by industry and the UK MOD that was first unveiled to the public at the 2017 Defence and Security Equipment International (DSEI) conference in London.

Trials began in 2018, followed by a later demonstration in 2019, at which, according to MBDA, these low power trials proved DragonFire's ability to track air and sea targets with exceptional accuracy. The laser and its associated targeting systems, including an electro-optical camera and a second lower-power laser for imaging and tracking, are mounted in a turret.

Reportedly, within the 50kW class its energy demands use the joint UK-US developed Flywheel Energy Storage System (FESS), which is still in its developmental stage, the technology of which was initially developed by the Williams Formula One team for use on their car's transmission. It stores rotational energy when the clutch is disengaged and can transfer that energy back once it's engaged again after a gear change.

The development of LDEW is regarded as a priority with the MOD. It is viewed as a faster and more economical way of dealing with kamikaze 'hobby' drone and missile attacks.

Current operations by the Royal Navy as part of US-led Prosperity Guardian in the Red Sea have seen *HMS Destroyer* shoot down Houthi drones with Sea

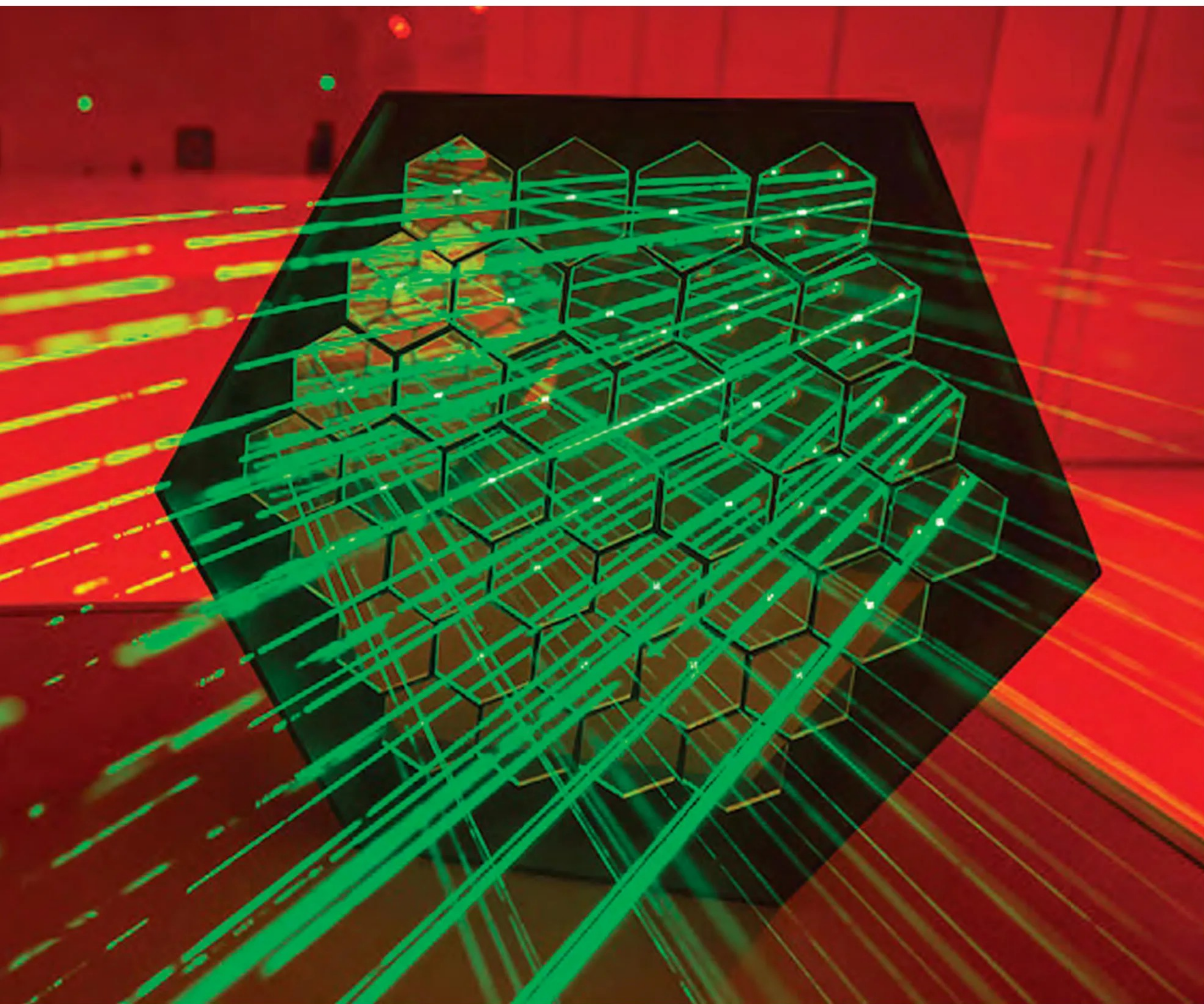
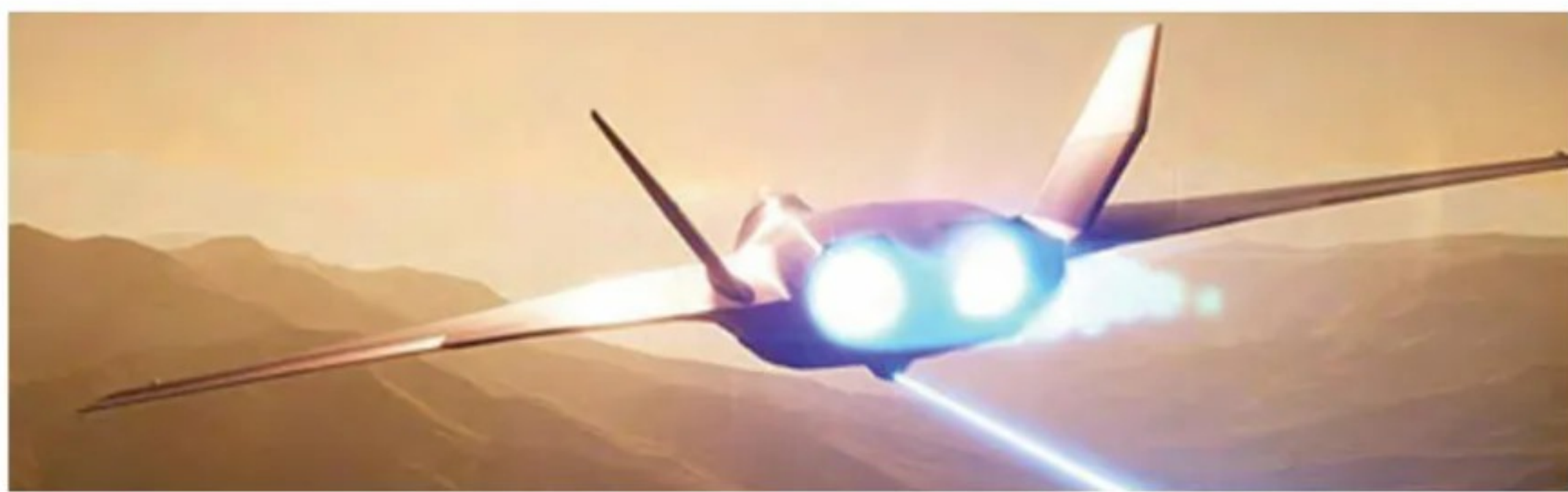
Viper missiles, which were targeting both merchant and military vessels in the region. Although successful, the UK is keen to introduce LDEW to the frontline as soon as possible, which it believes will be able to engage targets at the speed of light and use an intense beam of light to cut through the target, leading to the structural failure or significantly more if the warhead is targeted. The range of DragonFire is classified, but it has been confirmed that being a line-of-sight weapon, it can engage any visible target.

Firing the laser for ten seconds, more than enough to destroy any target, is the cost equivalent of "using a regular heater for just an hour", says the MOD.

DragonFire can potentially be a long-term, low-cost alternative to current tasks where missiles are fired. MOD has revealed: "The cost of operating the laser is typically less than £10 per shot."

Following completion of the trials in the Hebrides, Dstl's Dr Nick Joad stated: "This innovative application of science and engineering is the fruit of sustained investment and effort. DragonFire uses cutting-edge science and technology and delivers much greater performance than other similar systems of a similar class. DragonFire provides a step-change in our ability to deal with high-performance, low-cost threats."

Defence Secretary Grant Shapps



said the technology “...could reduce the reliance on expensive ammunition while also lowering the risk of collateral damage. Technologies like DragonFire are crucial in a highly contested world, helping us maintain the battle-winning edge and keep the nation safe.”

BAE Systems has already stated that the Tempest will be equipped with a range of sensors, including integration of LDEWs for self-defence and use within visual range combat is anticipated. The success of the DragonFire tests may lead to an offshoot development that will likely see the use of directed energy weapons on aircraft becoming a reality for sixth-generation aircraft. **AI**

MAIN IMAGE:

The MOD has revealed that DragonFire is precise enough to hit a £1 coin from a kilometre away
QinetiQ

TOP:

BAE has already produced a concept image of a rear-firing laser on Tempest to counter unmanned aircraft and missiles

BAE Systems

LEFT:

The DragonFire laser-directed energy weapon (LDEW) system has achieved the UK's first high-power firing of a laser weapon against aerial targets during a trial at the MOD Hebrides Range

QinetiQ

The E-7 is neither “the only known military-off-the-shelf/non-developmental system currently capable of fulfilling the strategic commands’ essential operational requirements and key performance parameters,” nor is it the only option “available for delivery within the timeframe required.” These were, however, presented as the reasons that the E-7 had been selected

Boeing

An acquisition strategy has been set out to obtain the Boeing E-7 as NATO’s next-generation airborne early warning, command and control aircraft. Yet this is not a sales contract and it is already provoking controversy, as **Jon Lake** explains

NATO’s E-7 controv



NATO has operated a multinational fleet of Boeing E-3A Sentry Airborne Warning and Control (AWACS) aircraft since the 1980s. The Sentry is based on the airframe of the Boeing 707 airliner, with an AN/APY-1 radar whose rotating antenna is housed in a disc-like rotodome mounted above the fuselage. Some 14 aircraft remain of 18 originally procured, based at Geilenkirchen air base in Germany and at forward operating bases in Italy, Greece, and Turkey, and a forward operating location in Norway. They wear Luxembourg markings and are manned by 30 multinational crews drawn from 17 of NATO's 29 nations (Belgium, Canada, Denmark, Germany, Greece, Hungary, Italy, the Netherlands, Norway, Poland, Portugal, Spain, Turkey, Romania, and the United States). The NATO AWACS aircraft have flown in every major NATO operation, including the fight against Daesh, and have been heavily committed on NATO's eastern flank following Russia's invasion of Ukraine.

To plan for the required follow-on capability after AWACS, at the 2016 Summit in Warsaw, NATO launched the Alliance Future Surveillance and Control (AFSC) to develop options for future NATO surveillance and control capabilities. In February 2017, the North Atlantic Council (NAC) initiated the AFSC Concept Stage with NSPA as the lead NATO agency to conduct studies and develop technical concepts. Through this work, the NATO Support and Procurement Agency (NSPA) is evaluating new technologies and exploring a system of systems approach, including potential combinations of air, ground, maritime, and space systems working together to collect and share information. All 31 NATO Allies currently co-operate in the planning and resourcing of this programme.

Acquisition of the E-7, one of NATO's biggest-ever capability purchases, is vital to its initial Allied Future Surveillance and Control (iAFSC) programme. As AFSC progresses, iAFSC will deliver





ABOVE RIGHT:
Two NATO Airborne Warning and Control System (AWACS) aircraft deployed to Lithuania to monitor the skies over eastern Europe, the first of these arriving at Šiauliai Air Base on 28 September 2023, with the other following
NATO

RIGHT:
The NATO E-3As are flown and operated by multinational crews. The aircraft deployed to Lithuania were manned by personnel from Czechia, Denmark, Germany, the Netherlands, Turkey, and the United States
NATO



an initial element to mitigate the risk of a surveillance and control capability gap as AWACS goes out of service. The Wedgetail will be integrated, as one contributing element, to the overall AFSC system of systems capability that will also include space-based, airborne and maritime ISR (intelligence, surveillance and reconnaissance) assets and will include the operational RQ-4 Alliance Ground Surveillance UAVs, as well as an in-development system of systems' architecture.

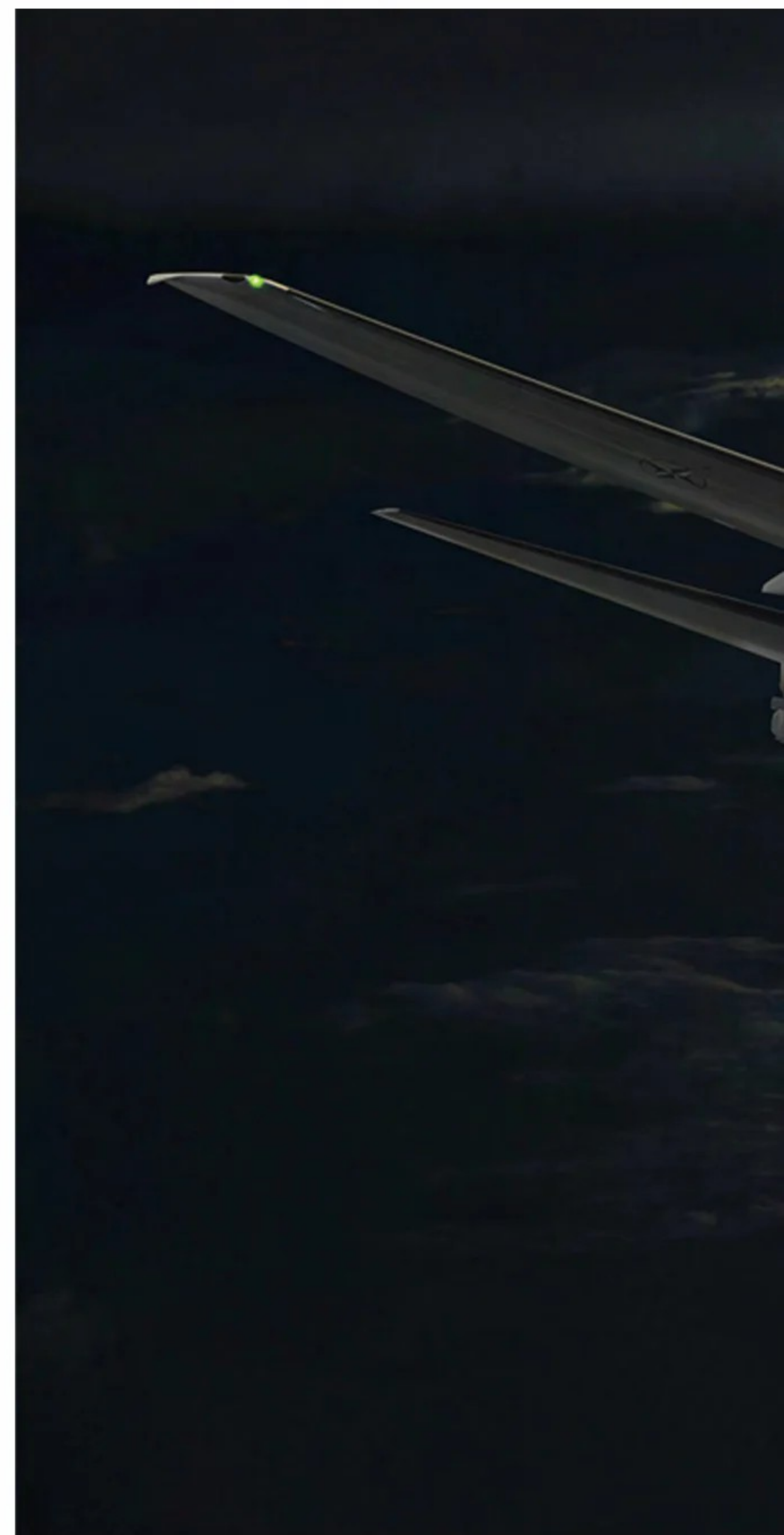
The Boeing E-7 Wedgetail (also known as the 737 AEW&C) is an advanced early warning and control aircraft based on the airframe of the Boeing 737-700, with a Northrop Multi-role Electronically-Scanned Array (MESA) radar whose 'top hat' antenna is mounted above the fuselage. The type is in service in Australia, Turkey and Korea and is in production for the British Royal Air Force and the US Air Force. A Royal Australian Air Force E-7A Wedgetail was recently deployed to Ramstein Air Force Base in Germany, arriving on October 19 for a six-month deployment. The deployment will provide NATO with an "additional early warning capability" in the wake of Russia's invasion of Ukraine.

Though it has been said that the AFSC system of systems will include different aircraft types, there are no plans for a split iAFSC purchase. A NATO spokesperson commented: "No Mixed

Fleet of aircraft types is envisaged within the iAFSC. However, the AFSC system of systems will be composed of various types of air platforms, and the overall AFSC system of systems architecture is still under development."

With E-7 numbers constrained by cost and production capabilities, more serious consideration should, perhaps, be given to operating just such a mixed fleet. A Saab spokesman said the company remains "very confident that GlobalEye is a competent AEW&C solution that can bring strengthened and crucial operational effect to NATO, be it sole-sourced or in a mixed fleet approach. Different solutions could provide increased operational flexibility, enable innovative tactics in demanding scenarios, pose new and unpredictable challenges to hostile forces, diversify NATO's sensor array and decrease dependency on maintenance and upgrade for legacy platforms."

The NATO Support and Procurement Agency, through its Support Partnerships framework, on behalf of the support partnership nations of Belgium, Germany, Luxembourg, the Netherlands, Norway, Romania, and a rigorous assessment process that included NATO and national experts, assessed industry's responses to Requests for Information (RFI) and Price and Availability (P&A), as well as the capabilities of firms identified on the NSPA Source File. The NSPA said: "This also involved defence industry research,



including comparable AEW&C acquisition programmes in Australia, South Korea, Turkey, the United Kingdom and the United States.” Interestingly, there was no research into the Emirati, Swedish, or Polish acquisition programmes or those undertaken by Israel, Italy or Singapore. The cynic might conclude that a decision in favour of the E-7 had already been made.

NSPA delivered an iAFSC capability Request for Information (RFI) solicitation to the industry in 2022, with competitors asked to outline aircraft pricing and

availability for an AWACS successor solution. Boeing responded to the Request for Information (RFI) – which was not an RFP – in January 2023, while on February 21, 2023, Saab announced that it had responded to the RFI. Northrop Grumman and L3Harris responded in the same timeframe.

NSPA declined to comment when asked whether the NATO aircrew had flown on the RAAF and Turkish E-7s or on the GlobalEye and CAEW as part of the process. Nor was it confirmed whether the evaluators had

canvassed the opinion of NATO aircrew who have flown on these types.

Building on the Bi-SC (Bi Strategic Commander’s) iAFSC Capability Requirements Statement of May 19, 2023, two Requirements Workshops were hosted by NSPA (May 31-June 2, 2023 and July 24-25, 2023) with the strategic commands and stakeholders. These were used to refine and validate iAFSC requirements and assess potential solutions’ ability to meet those requirements.

The NATO Support and Procurement [➔](#)



LEFT:
The E-7 combines an Open Mission Systems (OMS)-compliant battle management command and control (BMC2) system and an advanced, wide-band active electronically scanned array to produce a compelling AEW aircraft
Boeing

BELOW:
The E-7A has AESA arrays in a dorsal ‘Top Hat’ fairing, rather than a rotating mechanically scanned antenna in a rotodome like the E-3A. Fore and aft coverage is provided (with reduced range) by so-called ‘Endfire’ antennas in the ‘surfboard’ on the top of the fairing
Boeing





CLOCKWISE FROM ABOVE RIGHT:
The Saab air-to-air optimised WatchEye configuration, which mounts X-band AESA radars in the belly and in the tailcone to provide a 360° radar field of regard, is lacking in aircraft for the UAE and Sweden
 Saab

Saab flew the fifth GlobalEye on November 23, 2023, marking the fifth successful first flights in a period of just five years, and confirming Saab's ability to deliver the most modern AEW&C solution available in the market, and to do so at pace. The fourth GlobalEye had flown on April 3, 2023
 Saab

Saab offered the same configuration to NATO as it is offering in South Korea. The aircraft replaces the undernose EO/IR package and belly-mounted surface search radar with new forward- and rearward-looking X-band AESA radars. This fit, known as WatchEye, gives GlobalEye a 360° field of regard
 Saab

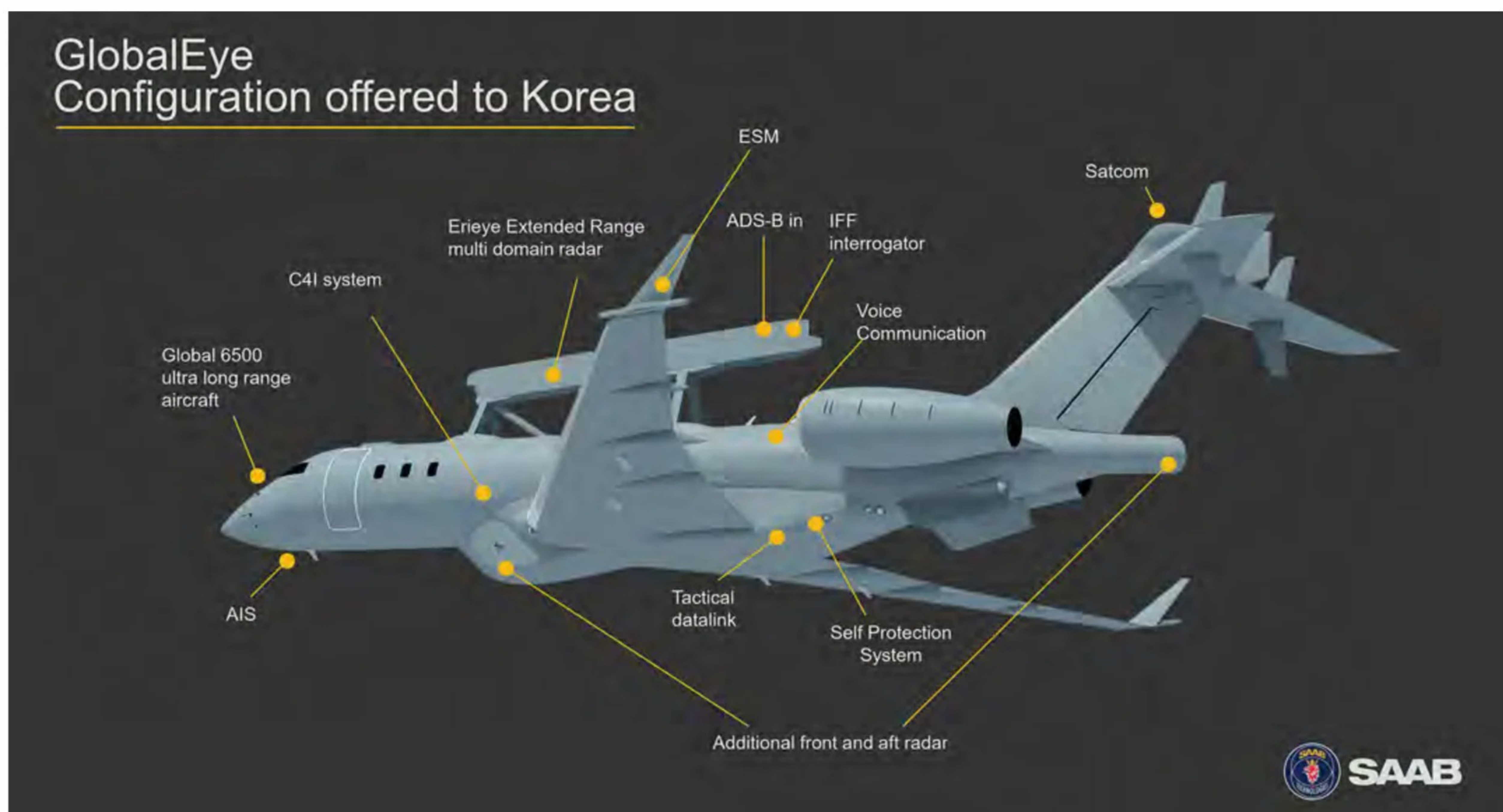
Agency identified the Key Performance Parameters (KPP) with supporting Measures of Performance (MoP) that were significant to the requirements of owners and users. Six of these KPPs were identified as being particularly important for assessing the system that was to be acquired:

- 1) *Aircraft Endurance and Capacity: particularly mission duration, crew size, number of operator workstations and crew rest facilities.*
- 2) *Mission System: particularly uniform display size and resolution for its operators.*
- 3) *Surveillance Coverage, particularly volumetric coverage.*
- 4) *Growth Capacity: especially size, weight and power.*
- 5) *Risk in Design and Delivery, particularly Information Assurance and Security Risk.*
- 6) *Survivability, especially cyber assurance.*

NSPA declined to say which of these KPPs the E-7 was felt to offer an advantage in, nor whether there were KPPs in which other contenders scored better than the E-7. This was because “some KPP include commercially sensitive/secret level information that cannot be disclosed”.

On November 15, 2023, the NSPA announced that: “NATO has selected its next-generation command and control aircraft as the Alliance's existing Airborne Warning and Control (AWACS) fleet nears retirement. Production of the six new Boeing E-7A Wedgetail aircraft is set to begin in the coming years, with the first aircraft expected to be ready for operational duty by 2031.” The agency added that the E-7A will ensure a “smooth transition from the existing capability across other lines of development and into the future.”

The value of the planned acquisition



“GlobalEye is based on the modern Global 6000/6500 platform that is already flying worldwide in significant numbers”

Carl-Johan Bergholm, head of Saab’s Surveillance business area

was not stated, but it was reported that a “...consortium of Allies gave their approval to the project”.

Some were surprised at the small number of aircraft ordered, not least since the NATO E-3A fleet seems to have been pretty stretched since it was reduced to 14 aircraft. Naturally, an operator will need fewer examples of a more modern, more available platform, but you still need one aircraft to support one orbit. It has been assumed that the small number of E-7As reflects a budgetary constraint (or a massively pared-back requirement).

An NSPA spokesperson told me: “Six is the minimum number of aircraft that the strategic commands state is required to deliver the minimum operational capability for SACEUR’s day-zero airborne air battle management capability. Wedgetail is also a more capable aircraft than current AWACS aircraft. Affordability is, of course, a factor.”

It was reported that the Wedgetail had

been selected due to its commonality with aircraft operated by NATO members and partners (British, Turkish, Australian and Korean Wedgetails, and, presumably, the growing fleet of P-8A Poseidons). It has also been suggested that the reach of the E-7’s sensors may have been a factor, along with its range and persistence. However, there is little evidence that the E-7 enjoys any significant advantage over its rivals in sensor or platform range or mission endurance. An active production line may also have been a factor (though this is true for GlobalEye).

Perhaps the most compelling advantages were the aircraft’s generous accommodation for a larger crew and crew rest. The Wedgetail’s proven design and perceived growth potential may also have been a factor.

NATO Secretary General Jens Stoltenberg welcomed the decision: “Surveillance and control aircraft are

crucial for NATO’s collective defence, and I welcome Allies’ commitment to investing in high-end capabilities. By pooling resources, Allies can buy and operate major assets collectively that would be too expensive for individual countries to purchase. This investment in state-of-the-art technology shows the strength of transatlantic defence co-operation as we continue to adapt to a more unstable world.”

NSPA subsequently explained that when the RFI phase ended, it had been assessed that the Boeing E-7A AEW&C (Wedgetail) was “the only known military-off-the-shelf/non-developmental system currently capable of fulfilling the strategic commands’ essential operational requirements and key performance parameters and available for delivery within the timeframe required.”

In response to direct questions, NSPA did not comment on whether it had



concluded that Saab's GlobalEye did not fulfil key user requirements (KURs) and KPPs, would not be available in the required timeframe, or both.

This doubtless came as a surprise to Boeing's competitors, all of whom presumably went ahead with their RFI submissions believing they met the requirements and KPPs and could deliver their solutions within (or even ahead of) the required timescale.

These competitors included Saab, offering a modified version of the GlobalEye, L3 Harris with a solution based on a Bombardier Global 6500 incorporating the IAI/Elta mission kit 'ported' from the Conformal Airborne Early Warning (CAEW) aircraft used by Israel, Italy and Singapore, and Northrop Grumman, who offered the E-2D Advanced Hawkeye.

Because "...some KPPs include commercially sensitive/secret level information that cannot be disclosed..." the NSPA did not disclose whether the RFI had included a target cost nor whether the various bidders had offered six aircraft.

Saab's response to the NSPA's Request for Information was based on its GlobalEye, though offered on a Global 6500, like its offering to Korea, rather than on the Global 6000. Carl-Johan Bergholm, head of Saab's Surveillance business area, said at the time that: "GlobalEye is based on the

modern Global 6000/6500 platform that is already flying worldwide in significant numbers and is characterised by high mobility and economic feasibility. Saab also brings to the equation an extremely flexible solution, i.e. one that is capable of dispersed operations. This is critical for flexibility, mission success and cost efficiency. The right size and the best system of systems performance is what counts, and Saab has that from the get-go, or in other words, from product design to product delivery and life cycle management."

"Saab is a proven and trusted part of NATO's defence industrial base, and we are present in more than two-thirds of the member nations. Our solutions, including GlobalEye, are developed from the outset to comply with NATO's requirements. I am confident we can contribute with important capabilities to strengthen NATO and benefit the member countries."

Following the Wedgetail decision, Bergholm told me: "We are fully compliant and submitted an offer which we can deliver faster than the delivery time requested. GlobalEye is a ready-to-operate product that we can also scale in co-operation with other industrial partners if required. Today, we can assure approximately 36 months of delivery time with very low risk and guaranteed output for the generic configuration of GlobalEye. That is possible because we have an





ongoing production, and we benefit from our combined experience as an aircraft manufacturer, radar powerhouse and support and services specialist to ensure high reliability and sustained operations for the complete solution.”

Bergholm was also keen to emphasise GlobalEye’s 360° radar field of regard since this has been a criticism raised. “We have indeed offered 360-degree radar coverage with fore and aft radars in this case, just as our current offer to Korea. Our offer also features air-to-air refuelling.”

“Technology is not a problem for us because we work together with our customer to provide a solution tailored to their specific needs. It is the same when it comes to offering more or fewer operator positions and other specific adaptations.



For the past 30 years, our users have selected features that are different from the old way of thinking. Our community’s feedback corroborates that our solutions deliver what is expected of them and are greatly appreciated.”

“Additionally, GlobalEye features a range of sensors that provide 360° coverage onboard: IFF, ADS-B, AIS and ESM. We can also see tracks up-linked from the ground.”

Bergholm says that “GlobalEye is meeting or exceeding all capabilities outlined in the RFI...” and insists that he “...remains convinced that GlobalEye is the best solution for NATO’s requirements in AEW&C in terms of capability as well as interoperability and availability” and said that Saab would welcome “further ➡

CLOCKWISE FROM ABOVE:

Though the combination of CAEW mission kit and the Global 6500 airframe is new, both elements of the new aircraft are tried and tested – the Global 6500 being in widespread service, while the G550-based CAEW has amassed considerable experience with Israel, Italy and Singapore

L3Harris

L3Harris showed off this model of its G6500-based CAEW at the recent Dubai Air Show. The configuration is unusual in dispensing with the usual dorsal antenna array, which significantly reduces drag. The Saab and L3 offerings are, in some respects, a generation ahead of the E-7, yet neither seems to have been seriously considered

Jon Lake

The final contender for the NATO AEW requirement was the Northrop-Grumman E-2D Advanced Hawkeye. The company did not respond to our requests for information

Northrop Grumman

Like Saab, L3Harris used a configuration developed for the RoKAF’s AEW requirement as the basis of its offer to NATO. The aircraft takes the radar and mission systems from the G550-based CAEW and ‘ports’ them across to a Global 6500 airframe, resulting in a long range, long endurance, high performance platform with a full 360° field of regard

L3Harris

using multiple broadband data links.

The cross-decked system from ELTA offers several other key advantages. The sensor and battle management systems are constantly updated using a Continuous Improvement/Continuous Deployment (CI/CD) model, taking advantage of ongoing CAEW operations in Eastern Europe and Israel. This model ensures the latest threat systems and battle management practices are rapidly integrated into the software baseline. In addition, the Global 6500 was first fielded in 2018, 20 years after others in the market, ensuring lower total lifecycle costs, no challenges with obsolescent parts, and a higher Operational Readiness rate. The highly automated mission system uses AI/ML to automate tracking,

(RRFS) suggesting technical solutions for the Alliance Future Surveillance and Control (AFSC) requirement, the company also offered its E-2D Advanced Hawkeye in response to NATO's request for information.

The company announced: "Northrop Grumman and select members of the ASPAARO team have responded to NATO's RFI with a solution that integrates the E-2D Advanced Hawkeye with enhanced networked capabilities, preserving the NATO vision of multi-domain command and control."

Janice Zilch, Northrop's vice-president for multi-domain command and control programmes, said that: "The E-2D will equip NATO and its member countries with technology that has continuously

RIGHT:

A Boeing E-7A in formation with MQ-28 Ghost Bat Collaborative Combat Aircraft. Many believe that the future of AEW will rely on large numbers of unmanned platforms carrying radar, perhaps feeding data back to a manned platform, or perhaps direct to the ground

Boeing

BELOW RIGHT:

NATO has selected the E-7A to replace its ageing Sentries. How six E-7As will replace 14 E-3As remains an unanswered question

Royal Air Force



clarification" around the alliance decision.

For its NATO RFI response, L3Harris leveraged the work it had carried out with IAI Elta on the Global 6500 AEW&C for the Republic of Korea. This solution 'cross-decks' the sensors and systems from the Gulfstream G550-based Conformal Airborne Early Warning (CAEW) aircraft operated by Israel, Italy and what L3 Harris coyly refers to as "other regions" (such as Singapore) and onto a military derivative of the Canadian-built, Bombardier Global 6500 large cabin business jet.

The aircraft uses an updated version of the Elta EL/W-2085 multiband radar system, with two S-band AESA arrays on each side of the fuselage and L-band arrays in the nose and tail, and leverages GaN technology. A common processor stitches together a common radar picture from all four arrays in real time, allowing the CAEW platform to provide a 360° field of regard without a draggy dorsal array. A powerful command, control and communication system integrates data from all onboard sensors, including Radar, IFF, ESM/ELINT, and offboard sensors

correlation, identification, and system performance. This automation allows six to eight operators to perform all the functions of the E-3 AWACS or the E-7 Wedgetail.

Finally, the conformal, aerodynamically integrated design of the missionised 6500 eliminates the costly, dorsal-mounted radar design. This aerodynamic approach permits a platform design that can fly higher (giving a greater sensor line-of-sight), faster, with greater mission duration and very high manoeuvrability. The L3Harris team focused on the principle that modern threats require an advanced 5th-generation AEW&C solution. It announced that it offered a similar configuration to NATO in July 2023, four months after announcing the Global 6500 CAEW platform for South Korea.

Though Northrop Grumman is a crucial partner on the E-7A, providing the platform's MESA radar, and though it was one of nine industry partners forming the ASPAARO (Atlantic Strategic Partnership for Advanced All-domain Resilient Operations) team conducting one of three Risk Reduction and Feasibility Studies



outpaced evolving threats...” and described the Advanced Hawkeye as “... the most comprehensive multi-domain battle management command and control solution at the most competitive operational cost.”

The E-2D may have been seen as an outlier, its performance and capabilities perhaps being judged to be significantly less ‘impressive’ than the other contenders, but with greater deployability and lower cost.

But in the end, the combination of commonality and interoperability with the USAF and airframe size led to the selection of the Boeing E-7A by NATO.

Boeing issued a press statement, saying: “We appreciate the confidence from the [NATO Support and Procurement Agency, or NPSA] and participating NATO nations in the proven capabilities and interoperability benefits of the E-7 Airborne Early Warning & Control (AEW&C) aircraft.”

The aircraft will be procured via the US Foreign Military Sales (FMS) process rather than a direct commercial sale. A Foreign Military Sales Letter of Offer and Acceptance is expected to be agreed upon in late 2024, with a contract award expected in late 2025. Initial Operational Capability (IOC) is planned for 2031, and the current AWACS fleet will be retired four years later, in about 2035.

Although 2031 is seven years away, some believe it is an ambitious target for even the first NATO E-7A to be operational. With a USAF requirement for 26 aircraft (all to be delivered by 2032) and a maximum production rate of four aircraft per year, the deadline is a tight

one, the more so given that low-rate initial production of the E-7 is not expected to begin until fiscal year 2025 (FY25, which runs from October 2024 - September 2025), while it will take some time to ramp up to the four aircraft annual rate. *Defense News*’ air warfare reporter Stephen Losey opined in August that: “...the Air Force’s ambitions to swiftly replace the E-3 in time for a potential fight against China, perhaps later this decade, are running into the realities of production limitations.”

Since deliveries of NG’s MESA radar seem to be a limiting factor, consideration has been given to buying the UK’s two ‘spare’ radars. No decision has been made yet; it will be part of the work towards finalising the contract award in late 2025.

The USAF’s program executive officer for digital services, Steven Wert, has said that the Northrop Grumman MESA radar production is one of the limiting factors for E-7 production. Northrop can build just two radars annually but wants to expand its annual production capacity to four. Even if it can do so by the second year of E-7 production (FY26), it is hard to see Boeing meeting the USAF’s target of 26 aircraft by 2032, and adding export aircraft to the programme will slow things down further.

The NSPA acknowledges that: “The timescale is ambitious, but the Support Partnership framework enables leveraging proven procedural and legal processes to implement complex multinational acquisitions.”

Then, there is the question of where the 737 airframes will be converted to E-7A standards. With the ongoing USAF

order, we asked Boeing whether it could produce six for NATO in time for them to be operational by 2031.

A company spokesperson said: “The E-7 has been assembled at four locations (USA, Australia, the Republic of Korea, and Turkey) and is being assembled in the UK now. The engineering design and process are mature, allowing flexibility for the customer. As NATO advances through its processes, Boeing will work with NATO to determine the best solution for delivering the capability and meeting NATO’s requirements.”

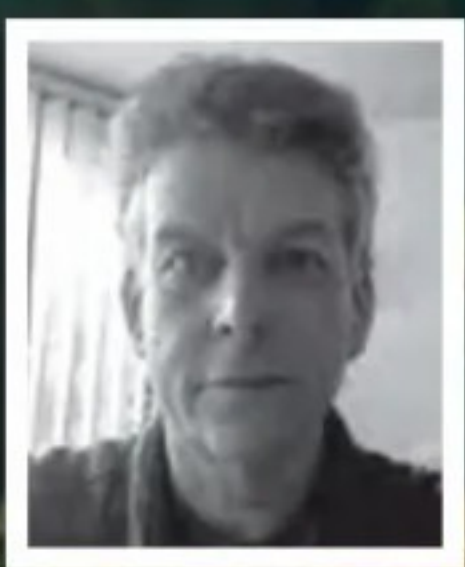
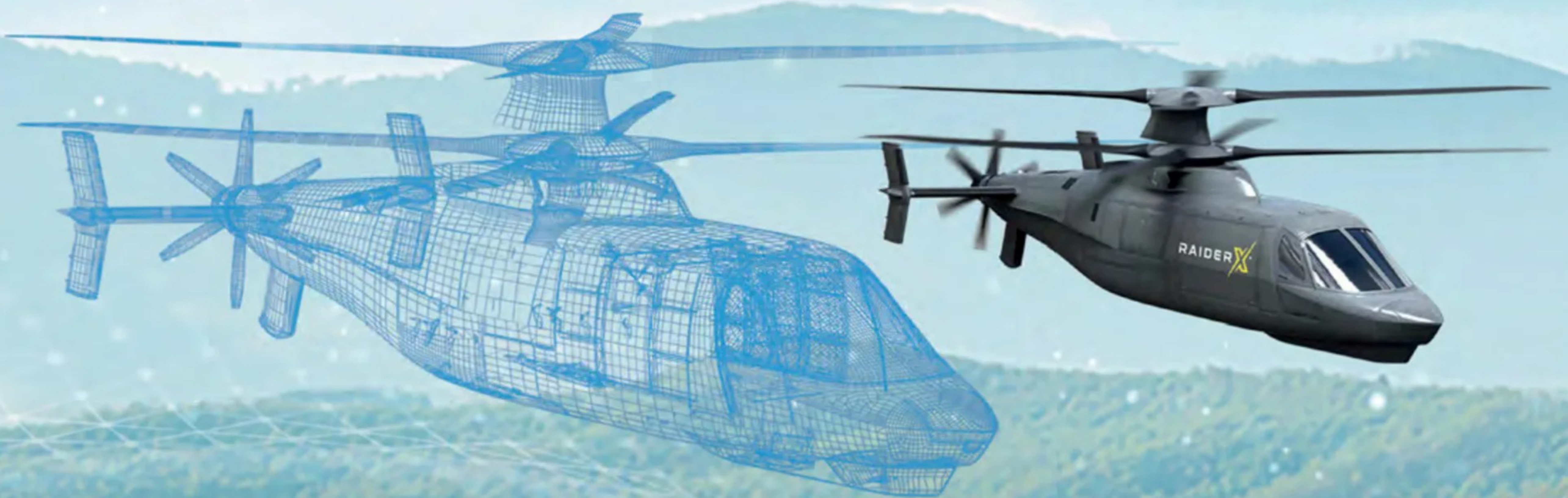
While it is the case that Boeing Australia, Turkish Aerospace Industries, Korea Aerospace Industries (KAI), and STS in Birmingham have all converted (or are converting) 737 airframes to Wedgetail standards, most encountered significant technical problems and delays, and only the Korean aircraft were delivered according to the planned schedule.

Many would question whether proper consideration was given to E-7 Wedgetail’s competitors in a field of excellent candidates. At the same time, the contention that the E-7A is “the only known military-off-the-shelf/non-developmental system currently capable of fulfilling the strategic commands’ essential operational requirements and key performance parameters and available for delivery within the timeframe required” is potentially difficult to argue. It seems that other (perhaps better and certainly cheaper) options have been dismissed in order to “have whatever the USAF is going to operate”, regardless of cost, practicality, and operational effectiveness. **AI**



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Glenn Sands

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The military light-lift helicopter market past is prologue?

Paul ‘Foo’ Kennard, former RAF Chinook pilot and MOD Requirements Manager, and now Director of Ascalon Defence Consultancy, continues his look at the helicopter market, this time focussing on the light sector, which has become a firm favourite for all militaries







Light helicopters often provide the ‘combat mass’ element of many armed forces. Their relatively low acquisition and operating costs make them an attractive proposition for large militaries looking to offload the burden of routine operations from their larger, more expensive assets and for smaller nations often operating within modest budgets. When the sheer flexibility of modern light helicopters is factored in, they can also make a compelling case for providing significant capability across the spectrum of rotary wing tasks: light utility, liaison, scout/reconnaissance, package escort, close support and even full-on attack capability are now all within the remit of the light role – a far cry from the temptation in the past to label them as merely a ‘Colonel’s taxi’.

While light helicopters have been part of the rotary wing landscape since the early days of helicopter aviation, it is, perhaps, only the advent of the compact gas turbine engine in the early 1960s that truly unlocked the potential of the small rotorcraft.

In the 1940s piston-engined Bell 47G offered a maximum disposable

payload (crew, cargo/pax, and fuel) of approximately 400kg and a cruise speed of 80km. The Bell 47, while capable by the standards of its time, was limited by what the heavy and complex 200hp piston engine could deliver.

By comparison, the similarly sized Gazelle helicopter of the late 1960s, with a 600hp Astazou turbine engine, had a disposable payload of nearly 900kg, as well as a top speed of almost 170kts – and, as the first helicopter I flew solo, I can assure you it was also a tremendous amount of fun and a machine that still evokes a fierce loyalty in many who have flown it – me included. This vast improvement in speed and payload enabled the single-engined light helicopter class to take on more battlefield roles than simple liaison, casualty evacuation and light resupply missions. When further enhanced by a second engine’s additional power, dependability and survivability, these gains were all the more impressive.

Albeit at extra acquisition and operating expense when compared to a single-engined machine, the ‘Light Utility Helicopter’ (LUH) has carved out its niche in the military helicopter Order of Battle – offering, in some cases, close to the

lift potential of a true Medium Support Helicopter (MSH) or the ‘punch’ of a dedicated Attack Helicopter (AH).

Importantly, as noted at the beginning of this article, the LUH, depending on type and weapons/sensor fit, can fulfil these tasks at considerably less cost than their dedicated MSH and AH equivalents.

The market for light helicopters is, in effect, split between the single and twin-engined categories. In many ways, it’s been like this since the 1970s. In the US, the single-engine OH-6 Cayuse (invariably called the ‘Loach’ by its crews after corruption of its designation of ‘Light Observation Helicopter’) and later OH-58 Kiowa series provided the ‘aero scout’ function for the US Army, primarily tasked with battlefield reconnaissance and light attack, a role similar to that performed by the Gazelle across many European armies, including both the UK (alongside the Westland Scout) and France. Indeed, the Gazelle still soldiers on with the French Army and was only retired as recently as October 2023 by the British Army. However, Germany bucked the trend and purchased the locally produced MBB Bo105, a twin-engined design.

The reason for Germany opting for the

Bo105 was not just industrial politics but a clear military requirement for a large force of light and cheap Anti-Tank helicopters to help resist any Warsaw Pact armoured thrust as an opening gambit of World War Three. The Bo105 was a much admired and dearly loved machine, with exceptional manoeuvrability thanks to its pioneering hingeless rotor system. This feature continues to be exploited today at countless airshows and other events by the pair of Bo105s operated by the Red Bull-funded Flying Bulls classic aircraft collection. With plenty of power, the hingeless rotor and dual hydraulic boosted flight controls, the Bo105 was the perfect platform for the Nap of Earth (NoE) tank hunting role as specified by the Bundeswehr. Fitted with weapon pylons capable of carrying up to six HOT (Haut subsonique Optiquement Teleguide Tire d'un Tube) anti-tank missiles and the necessary sighting and command link systems to guide the missiles to their targets via trailing command wires, the job of the Bo105 in the anti-tank role was to 'shoot and scoot' in the flanks of enemy armoured columns. The high speed and NoE capability enabled the Bo105 to get close to the targets while remaining terrain masked and to escape before return fire was received. The Bundeswehr purchased over 200 Bo105s for anti-tank units and a further 100 for more conventional light liaison tasks.

The Bo105 gave Germany a cheap and potent anti-tank capability through the

1980s and helped define the requirements that later led to the development and fielding of the Tiger AH.

The key reasons Germany felt they needed a dedicated AH were the increased risk posed by more capable Warsaw Pact mobile Air Defence units and better night/all-weather attack capability. However, later in this article, we'll look at more recent decisions made by Germany that might suggest they revisit the need for a modern equivalent to the capability offered by the Bo105.

The UK, too, recognised the need for more Anti-Tank capability and purchased the Lynx AH.1 in large quantities. An Anglo-French twin-engined LUH (and maritime helicopter), the Lynx has proven to be a long-lasting and rugged aircraft – with the digitally updated Leonardo AW159 Wildcat being, in effect, (and dubbed by many users...) the 'Lynx Mk 10'.

Equipped with the US-made TOW (Tube launched, Optically tracked, Wire guided) missiles, the Lynx was also highly manoeuvrable and had a useful cabin area that could both carry additional TOW reloads for high-intensity combat, as well as small numbers of troops or light cargo.

The UK operated the Gazelle and Lynx together as a classic 'Hunter Killer' pair, with the smaller and harder-to-detect Gazelle scouting for targets to pass to the Lynx for prosecution – allowing the Lynx crew to plan their attack for optimal results and increased chance of survival. As with Germany, however, the UK reluctantly

OPPOSITE:

The Sikorsky Raider X is a compound helicopter concept with two coaxial rotors and a single pusher propeller, that is competing for the US Army's FARA prototype competition

Sikorsky

BELOW:

In 2016 the OH-58D Kiowa Warrior was retired from the US Army after 33 years service. The US Army has been looking for a suitable replacement ever since
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conceded that the threat assessment was becoming too dangerous for legacy platforms such as the Lynx to survive and that a dedicated AH was required for all weather, day/night operations in such a contested environment, as well as to bring more modern and complex weapons to the fight – including a trainable 30mm cannon for soft-skinned vehicles, light armour and troops caught in the open. After a long and sometimes torturous process, the AH-64 Apache was selected for the UK, but with a twist – the aircraft would be extensively refitted with UK-sourced equipment (including engines and survivability systems) and assembled by Westland Helicopters at their plant in Yeovil.

Unlike the mixed bag that reengineering the F-4 Phantom had been in the UK, where the Rolls Royce Spey engines were good ‘low down’ but poor ‘high up’, the introduction of the RTM322 engines gave the UK’s Apaches significantly better performance, especially at high-Density Altitudes found in theatres such as Afghanistan, enabling them to carry their Longbow Fire Control Radars (FCRs) and a useful fuel/weapon load. At the same time, other nations had to remove their FCRs. As an aside, although there were few traditional FCR targets to be found in Afghanistan, it was always reassuring for me to fly a Chinook in theatre with a UK AH-64 on my wing – the FCR proving very handy at sweeping the airspace ahead of us for UAVs and other air users who were not sticking to their allocated height bands...

For years, the largest helicopter user in the world, the US Army, also employed a scout/attack pair of light helicopters, with the OH-58 Kiowa finding the targets for the AH-1 Cobra and, latterly, the AH-64. By the end of the 1980s, the US Army also realised that the OH-58, a militarised version of the civilian Bell 206 Jet Ranger, was ageing and vulnerable to the new breed of threat systems on the increasingly complex battlefield.

The US answer, as it invariably is, was to throw the full force of its technological resources at the problem. The resulting design, the RAH-66 Comanche, threatened to destroy the concept of the ‘light and affordable’ military helicopter.

The Comanche was exquisite in many ways. Carefully honed to survive in the full glare of the expected threat of the early 21st century, the RAH-66 was, in hindsight, the right helicopter at precisely the wrong time. Its twin-engine configuration (both buried in the fuselage to reduce IR emissions) and low observable qualities, including F-117-style ‘faceting’, internal weapons storage, clever rotor system shaping, and the use of Radar Absorbent Material (RAM), all combined to give the aircraft a vanishing small signature, both in Radar Cross



Section (RCS) and IR terms, by helicopter standards. Though still classified, the RAH-66’s RCS was reputedly similar to a single Hellfire missile from the frontal aspect. The aircraft was quick and very manoeuvrable, its digital Fly-by-Wire (FBW) control system demonstrating its ability to fly over 60kts sideways and 80kts backwards.

However, this exquisite capability came at an equally bespoke price. While the largely ‘off the peg’ OH-58 was cheap to buy and operate, by the end of the 1990s, the army was already facing significant questions about the Comanche’s affordability. The end of the Cold War and the expected ‘Peace Dividend’ effectively removed, at a stroke, the monolithic threat that the Warsaw Pact had presented. The 1991 Gulf War seemed to confirm that legacy Western equipment was also highly lethal against their Soviet-era opponents.

The original program for the Comanche foresaw a need for 1,200 airframes; for affordability, this was reduced in 2002 to ‘just’ 650 aircraft – but still with a projected total program cost, including development and certification, over US\$25Bn.

By 2004, with the Global War on Terror underway on multiple fronts and increasing wear on their ‘core’ fleet of Black Hawk, Chinook and Apache platforms, the army decided to cancel the Comanche and redirect the funding towards the sustainment and digital enhancement of their ‘big 3’ legacy types. The AH-64E, CH-47F and UH-60M were all the beneficiaries of this change in direction. As far as the army and many politicians were concerned, according to a 2003 Congressional Report into the program, the Comanche had been optimised with “capabilities and mission requirements... in response to a Cold War





threat environment that no longer exists”.

The army wrote off the \$7bn already sunk into Comanche but expected to save billions more by cancelling before full production started. Many in the community, fresh from experience in Bosnia and Kosovo, saw UAVs such as the Predator as a partial solution to the Scout function, possibly backed up with a simpler and cheaper replacement for the Kiowa. The return of the ‘true’ scout helicopter seemed assured with the announcement of the Armed Reconnaissance Helicopter (ARH) project shortly after the cancellation of the Comanche. Exploiting the marketplace for civil designs, ARH sought a Commercial off-the-shelf (COTS) solution. Updated designs from the past were pitched; Boeing (now the owners of Hughes helicopters) proposed a variant of their OH-6 derived MH-6 Little Bird, while Bell offered a refreshed Kiowa based on the Bell 407. Bell was selected, and over 350 ARH-70

Arapaho helicopters were ordered. Alas, the ARH project was plagued with cost overruns and accidents. By 2007, the project was in deep trouble, and a ‘stop work’ order was issued. Despite efforts to realign the program, the flyaway cost per airframe had nearly doubled from the planned \$9m to \$15m, and a Nunn-McCurdy breach was reported the following year as the total program cost had now risen by over 40%. The eventual cancellation relieved Bell, who stood to lose money on every airframe they built, but it was the start of a long nightmare for the army, who had to soldier on with ageing and increasingly obsolete OH-58s. Yet another project, the Armed Aerial Scout (AAS), which Sikorsky designed the S-97 to fulfil, also foundered on the rocks of affordability. As a consequence, the Kiowa remained in service until 2017. It was eventually ‘replaced’ by repurposed AH-64s in the ‘scout’ role –

an expensive and unpopular exercise in overkill, especially within the ranks of the National Guard who were forced to hand back a large chunk of their AH-64 fleet to the regular army to replace the Kiowa. Trading in their Apaches for Black Hawks did not sit well with many Guard units, nor their valuable pilots/maintainers, and many of them left. The army was now between a rock and a hard place. High tech, high cost had failed. Low-tech, supposedly low-cost ‘Off the Shelf’ had also failed. The requirement for a light scout platform endured – especially as it became clear that the likes of Predator would not be survivable in a near-peer confrontation. The army embarked upon an ambitious modernisation portfolio for its Aviation needs; dubbed ‘Future Vertical Lift’ (FVL), the project aimed to take a holistic view of the army’s rotorcraft needs and how investing in new technology might



CLOCKWISE FROM LEFT:
Introducing the Martel Lightweight Multi-Role Missile (LMM) into service on the Wildcat adds an essential layer of defence to the Royal Navy's Carrier Strike Group. The laser beam-riding missile is guided onto the target by a laser designator on the helicopter
MOD/Crown Copyright

The Boeing AH-6 is a series of light helicopter gunships based on the MH-6 Little Bird and MD500 family. It is specifically designed for superior performance and incorporates a flexible weapons configurable mission suite
Boeing

Designed primarily as a light observation and utility helicopter, the Gazelle proved its versatility with the Army Air Corps, taking on the additional roles of battlefield communication, directing artillery fire and anti-tank roles. After 49 years in service, the type was retired in October 2023
MOD/Crown Copyright

support several roles. The Future Attack and Reconnaissance Aircraft (FARA) program was established for the 'light' requirement. Two companies (Bell and Sikorsky) were selected from an initial field of five bidders to build prototypes for a competitive fly-off. Both aircraft should be well into their flight test programs by now, but severe delays to the new T901 Improved Turbine Engine have resulted in neither the Bell 360 Invictus nor Sikorsky Raider-X making a first flight at the time of writing (January 2024). Both companies reported delivery of T901 engines in late 2023, so 2024 will be a big year for both companies, especially Sikorsky, who need a 'win' after losing the Future Long Range Assault Aircraft (FLRAA) medium-lift Black Hawk replacement competition to Bell.

However, the army has successfully introduced another light helicopter into service, bringing us back to the utility of 'dual use' civil/military designs in light rotorcraft roles. As part of the 'Comanche Cancellation Dividend', the US Army

identified a need for a Light Utility Helicopter (LUH) for domestic tasks, such

as homeland security, liaison, medevac, and general support roles – releasing the more valuable UH-60 Black Hawks for overseas and contested deployments. The LUH would not require complex and expensive Aircraft Survivability Equipment (ASE) or weaponisation as a domestic support platform. The army selected the Airbus H145 as an 'Off the Shelf' solution, effectively taking the civil aircraft, fitting a military multi-mode radio (AN/ARC-231) and painting it green. Dubbed the UH-72A Lakota, over 300 have been delivered to the army for the domestic support mission. Although the majority are 'plain' aircraft, those assigned to homeland security roles (including counter-narcotics and border security) have additional kit fitted, including an EO/IR turret, datalink, and video recording technology (for collecting evidence) and a searchlight/rescue hoist. The Lakota has proven popular and successful with the army and its crews, and the service has resisted several attempts by lawmakers to weaponise it or adapt it for the scout role.

The army is very wary of protecting its budget and FVL Portfolio; a weaponised

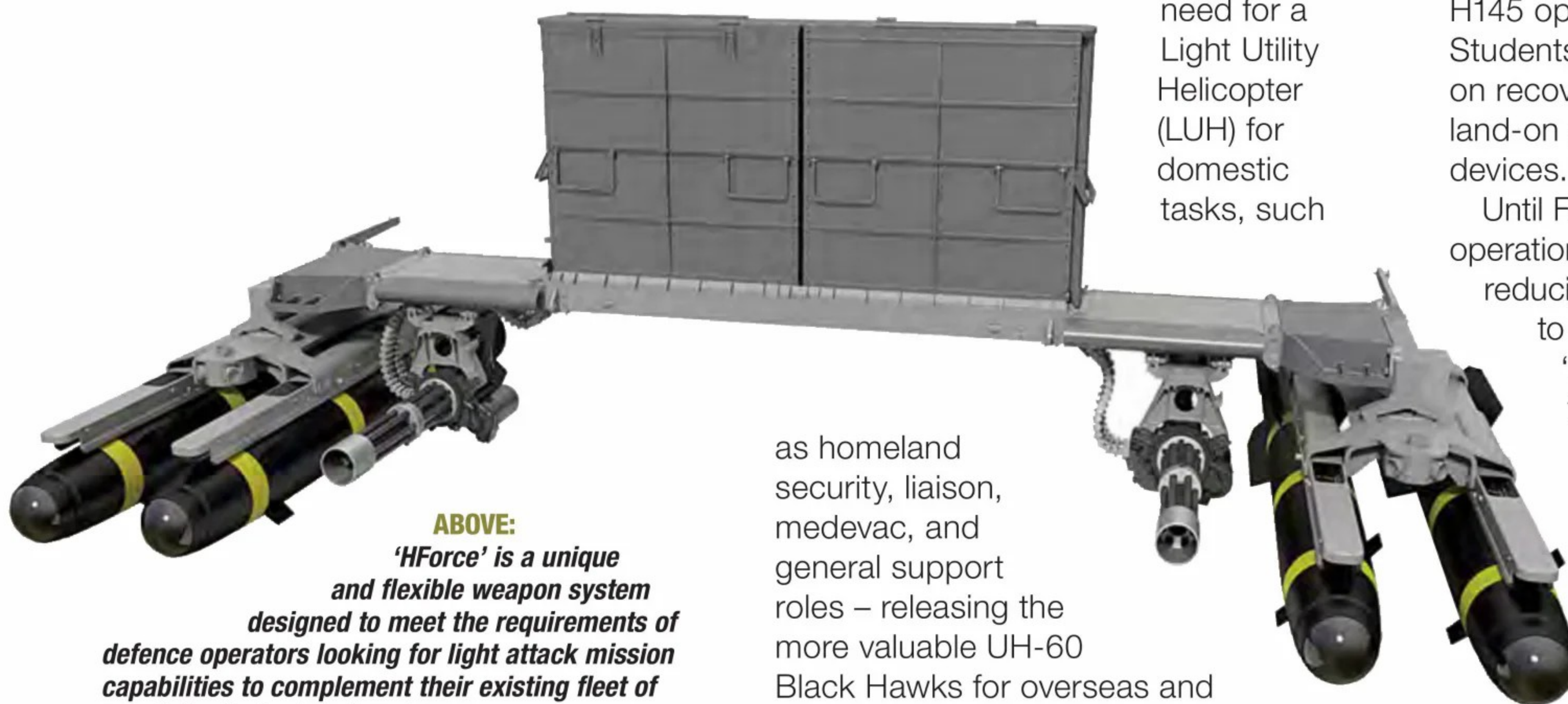
Lakota would threaten the FARA project and even AH-64 numbers.

In the UK, the Army Air Corps has been accused of similar politicking over refusing to follow the Royal Navy in fitting guided weapons to their aircraft, keeping a door gun capability more in keeping with its 'Find' role and not threatening to encroach on the Apache's 'turf'. However, the US Army has purchased over 100 additional UH-72As as their helicopter training platform at Fort Novosel – a move that is not without controversy given the cost and complexity of the twin-engined Lakota over the single-engine TH-67 it is replacing. There is also the small matter that the aircraft cannot be routinely flown to the ground on practice autorotations – long seen as a core skill for helicopter pilots during training. A combination of the hingeless, elastomeric rotor head is susceptible to cracking if exposed to sustained power-off autorotations to the ground, and a very 'lively' Nr (rotor speed) during autos combine not to make the 'juice worth the squeeze' for most H135/H145 operators – including the US Army. Students can complete autos to a power-on recovery at hover height and practice land-on autorotations in synthetic training devices.

Until FARA enters service, all US Army operational platforms will be twin-engined, reducing the likelihood of crews needing to conduct a power-off landing 'for real' and, if they do, then they could perhaps consider the 'deal' I always struck with any helicopter that I flew – that I'd use the energy in the rotor system and the impact properties of the airframe to save my life, and that of my crew/passengers; if the aircraft was flyable again afterwards it was a bonus...

While I continue to appreciate the need to teach student pilots the technique for engine-off landings, in my opinion, continuing the last 10-15ft to the ground for practice is a disproportionate risk, given the low probability of occurrence.

While the US Army may be shy about arming the UH-72A, other nations are increasingly less worried about weaponising their light helicopters – and using modern technology, significant 'bang for buck' can be generated. The base aircraft for the UH-72A, the H145, now comes in a 'H145M' variant. Fitted with Airbus' 'HForce' modular and scalable weapon/sensor system, the H145M can pack a considerable punch. HForce consists of a core Stores Management System and weapon targeting computer, coupled to an optional helmet-mounted display (HMD) for the pilot(s) and EO/IR turret for target identification and if fitted with the required module, laser designation. Cleared weapons include rifle calibre




ABOVE:
'HForce' is a unique and flexible weapon system designed to meet the requirements of defence operators looking for light attack mission capabilities to complement their existing fleet of specialised attack helicopters

Airbus Helicopters

OPPOSITE:
Although intended for Airbus models, 'HForce' can be installed on multiple types, including the AH-6 and MD 500 family, covering the full spectrum of operational missions, such as air-to-ground, air-to-air and air-to-surface

Boeing



“The market for light helicopters is, in effect, split between the single and twin-engined categories. In many ways, it’s been like this since the 1970s”



machine gun pods, cannon pods, unguided rockets (or guided if equipped with the laser designated BAES Advanced Precision Kill Weapon System – APKWS), anti-tank missiles (optical/laser guided) and even the potential for air-to-air missiles such as the air-launched versions of the Mistral 3, Stinger, and Starstreak High-Velocity Missile (HVM). Key factors that enhance HForce’s attractiveness are that a purchaser can buy the entry-level capability (effectively guns/unguided rockets) and incrementally enhance the system as requirements and budgets allow.

There is a sharp increase, for example, in the cost of training and currency flying/weaponer by the time the ‘full up’ HForce with HMD and EO/IR is fitted – and many customers will never need that level of complexity, nor be able to justify the expense.

HForce is also adaptable across Airbus’ product range, meaning that a country which, for example, used the H125 as a scout, the H145 as an LUH and an H225 as an MSH could use a central pool of components and weapons to support all three airframes.

Perhaps the strongest endorsement of the ‘HForce’ concept was the announcement by the German military in December 2023 that they were placing a \$2bn order for 62 H145Ms (plus 20 options) with Airbus Helicopters. As the H145 line is ‘hot’, deliveries are expected to start in 2024 and be complete by 2028, with the aircraft being split between the German Army (57) and the Luftwaffe’s Special Ops units (5) – (see, News, February, pages 8-9). The size of the order was a shock to many in the industry. It’s an example of yet more ‘Past

is Prologue’ thinking (stirring memories of the Bo105 PAH role described earlier) and, potentially, an indicator that Germany no longer sees the Tiger as a viable long-term solution to all its armed helicopter needs. Although the acquisition is deemed the ‘Light Attack Helicopter’ (LKH) by the Bundeswehr, Germany has recently gone on record expressing its concerns about the Mid Life Update (MLU) for the Tiger (the ‘Tiger III’) being proposed by France and Spain. Germany has determined it’s too risky, has declined to invest, and confirmed that its Tigers will be withdrawn by 2038 at the latest.

A large fleet of H145Ms could, in theory, supplant the expensive and often unreliable Tiger earlier – perhaps at the turn of the decade, especially if proposed upgrades to the H145M, such as the integration of the Israeli-



The Bell 360 Invictus is a proposed helicopter design intended to meet the US Army's FARA requirement. The aircraft leverages a common open architecture digital backbone comparable to the Bell V-280 Valor
Bell

designed, European-made SPIKE missiles and enhanced Defensive Aids/Ballistic Protection was provided. Some German sources describe the H145M purchase as a 'stopgap' between the retirement of the troublesome Tiger and the development of a new combat ecosystem of UAVs and loitering munitions.

Germany has been shocked by the scale of the war in Ukraine and equally as shocked by the parlous state of the Bundeswehr – especially in terms of availability, the German defence minister noted that only nine out of 51 Tigers were operational at one stage in 2022.

Much of Germany's current thinking seems to be about rebuilding a hollowed-out military with reliable, available 'off-the-shelf' equipment rather than continuing to invest in high-risk development projects. The money for the H145Ms will come from

the additional \$100bn allocated to defence. Recreating the concept of the Bo105 force, utilising armour and mechanised infantry to slow down an advancing Russian Army, has not looked so needed since the mid-1980s. As a final irony, the H145M is derived from the BK117 aircraft, which, in turn, used a rotor system closely resembling that of the Bo105.

Airbus is not alone in sensing the 'pull' from the market for cheaper, modular, and more flexible armed helicopters. The twin descendants of the OH-6 Cayuse have never stopped being marketed and sold as light attack platforms. When Boeing bought McDonnell Douglas, they retained the MH-6 Little Bird within their product portfolio and still produce the aircraft in enhanced form for the 160th Special Operations Aviation Regiment (and others) alongside the AH-64E Apache at their

Mesa, Arizona, facility. However, the commercial side of McDonnell Douglas remains independent as MD Helicopters and has been selling the MD500/MD530 to civil users for decades.

They also offer armed versions that compete directly with the MH-6 on the international market – although they frequently incur the wrath of Boeing's lawyers, who claim that the 'divorce agreement' placed restrictions on what MD could sell and to whom. Finally, in 2013, a court case found that MDs were not restricted from offering the MD500/530 (and versions thereof) to any customer, domestic or international. While MD will sell you a weaponised MD500/530 from the factory, it is also possible for customers to purchase 'stock' helicopters, new or used, and fit them with aftermarket weapon kits. ➔



Several significant arms companies, such as FN Herstal, Moog, Fulcrum Concepts, and Dillon Aero, among others, all offer such ‘off the peg’ solutions for several helicopters, not just the MD 500/530 but also the Bell 407 and Airbus H125/H130. For many installations, the system is based on a ‘plank’ in the helicopter’s rear cabin and protruding into the airflow on both sides. The cabin portion of the plank acts as a mount for the Stores Management System and any fitting targeting system, while the portions in the airflow are used as mounts for weapon pylons and sensors. The beauty of a ‘plank-based’ design is that it does not rely upon the aircraft having provision for External Stores Systems (ESS), which usually function only on dedicated military aircraft. Noting the number of third-party weaponised MD, Bell, and Airbus helicopters at recent trade shows, it is clear there is a growing need for cheap,

reliable, and plentiful airframes to fulfil the light attack and scout roles.

Space prohibits further discussion of the light helicopter market, including the potential for eVTOL designs to enter the fray when more mature. Still, I hope the reader has gained insight into its vibrancy. From the cutting-edge designs that will fly off for the FARA competition to the continued presence of updated old warhorses and the current trend for ersatz weaponisation of previously unarmed platforms, the choice for a potential buyer in the light category has never been broader or more fluid. It emphasises the need for a solid set of User Requirements and a pragmatic approach to delivering or trading.

As with UAVS, if a light helicopter becomes too complicated and complex, it risks becoming too expensive to buy or too valuable to deploy in dangerous scenarios. Fitting Missile Warning Systems, countermeasure dispensing

systems, DIRCMs and armour may improve platform protection by valuable percentage points. Still, they do so at the cost of weight and operating expense – potentially making it better value to buy a dedicated AH or larger MSH. The principal value of the light helicopter is that it can be purchased and employed at scale; after all, quantity has a quality all of its own.

If Germany buys the full 82 H145Ms, then they will once again have an available, reliable, and potent light attack capability – and one that will be very capable of punching above its weight. It remains to be seen whether other European nations conclude that ‘the past is prologue’ and consider trading in their ‘boutique’ capabilities for something lighter, more ‘off the peg’, and affordable in numbers. The light helicopter looks set to be a fixture of many militaries for decades. **AI**

TOP:

Set to replace the Eurocopter Tiger within the German Bundeswehr, the Airbus H145M will serve in the light attack role armed with Rafael Spike LR guided missile

Airbus Helicopters

RIGHT:

The robust, articulated rotor, lift-sharing wing and optimised tail rotor will allow the Bell 360 to deliver advanced speeds, range and agility over the battlefield

Bell



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Rights on flights

Proposed legislation to the UK Parliament aims to ensure that the disabled will no longer need to fight for their rights when travelling by air, as **Bernie Baldwin** reports

“The space where we are most vulnerable, but we don’t have robust enough laws in place to protect us, is in air travel. Personally, when flying, I’ve been ignored, abandoned, abused, dehumanised and humiliated. I’ve even had my chair broken on more than one occasion. And I know I’m not alone.” That was why BAFTA-nominated TV presenter, producer and writer Sophie Morgan became a co-founder of Rights On Flights, a global initiative dedicated to “ensuring that every airline passenger who requires support at any point enjoys

a safe, dignified and comfortable journey.”

Campaigning alongside Sophie are the founders of Flying Disabled, Chris Wood, founder of ableMove UK, Josh Wintersgill and Roberto Castiglioni, director of Reduced Mobility Rights. They describe themselves as “having a passion for championing the rights of all flyers.”

The pinnacle of the group’s work so far is the creation of The Assisted Air Travel Act, which is being put forward as legislation to the UK Parliament. Officially launched in September 2023, the proposal follows the UK government’s open acknowledgement that the enforcement powers of the UK Civil Aviation Authority (CAA) are not strong →



ABOVE:
The Air4All powered chair is locked in place in the cabin

All images via Bernie Baldwin

LEFT:
The fitted cabin seat is folded, ready to take the Air4All chair

“It will be no easy feat, but we want to create a framework that doesn’t put the industry in an unwanted position”

Josh Wintersgill, founder, ableMove UK



enough in this area and their promises to introduce legislation to strengthen them. In the Foreword of the Act, the four authors note that the disability community “has had enough of dreadful headlines and demands practical solutions.”

That comment ties in with the experiences that drove Morgan’s efforts to right wrongs with regard to access for people with disabilities – and not just in the air. She explained: “From the moment that I rolled out of hospital as a permanent wheelchair user and a complete paraplegic 20 years ago and came face to face with the many barriers, physical or otherwise, that people like me have to endure, I knew that my life was going to be one long fight.

“The first fight came when I tried to further my education. I had a place at university waiting for me after my injury. But when I went to enrol, I was told that they couldn’t accommodate me as I was now a wheelchair user and that I wouldn’t, therefore, be able to attend. I was shocked. I didn’t know then that I would need to know the laws that protected me. My mother called a lawyer friend and we went back to college together. We told them that they were breaking the law. So they built a disabled toilet and decided to make one of the ten classrooms accessible, so I took up my place.

“This was my awakening to the importance of knowing my rights I also learned that doing something for me could also help others, as I got a letter thanking me from a girl who also used

a wheelchair and enrolled a year later. But the Equalities Act – or the Disability Discrimination Act, as it was known then – can only protect us so much.

She moves on to further examples of the disabled community not being treated equally: “If non-disabled people were having their legs broken at the same rate that we are having our chairs broken, there would be an outcry. And yet there are 32 chairs broken every day in the USA and it’s going up, so it’s safe to say we are in a crisis.”

After her chair was broken in early 2023, Sophie joined forces with her partners

to establish Rights On Flights, raising awareness of the challenges facing the disabled and creating solutions: “We’ve now launched the Assisted Air Travel Act, draft legislation that could put an end to the need to fight for our rights on flights. This Act could usher in a paradigm shift in how disabled people travel.”

To create the draft proposal, people with disabilities shared their experiences, and the aviation industry offered its knowledge and expertise.

Before getting into the Act’s Definitions and General Provisions, the authors state: “The purpose of this Act is to



“We’ve now launched the Assisted Air Travel Act, draft legislation that could put an end to the need to fight for our rights on flights”

Sophie Morgan, co-founder, Rights On Flights



promote, protect and ensure the full and equal enjoyment of all human rights and fundamental freedoms by all persons with disabilities when travelling by air.”

Central to the draft are “five essential tenets” to deliver a seamless blend of harmonisation, inclusion, transparency, accessibility and fairness. Josh Wintersgill explains the reasoning behind these: “We know that the international landscape is a legal minefield for harmonisation. IATA is doing a lot of intense work to overcome this. It will be no easy feat, but we want to create a framework that doesn’t put the industry in an unwanted position of

double compliance between significantly different rules.” Thus harmonisation is essential within the Act, eliminating discrepancies and enabling easier adherence to compliance standards.

Wintersgill continued: “On inclusion, the proposal best defines the sphere of influence and accessibility forums, and importantly sets clear targets for the recruitment of disabled people in the aviation sector.”

The Act expands on his comment, saying that inclusion is “a fundamental principle that we must all strive to uphold, and the proposal takes a huge step forward. It seeks to ensure the disability community is properly represented in supervision and decision-making roles and provides more opportunities for disabled people to pursue a career in aviation.” Notably, the inclusion section in the draft also covers points such as viewing mobility aids as an extension of the person. It also recommends creating processes around compensation for carers when they are deemed essential.

Regarding transparency and clarity, Wintersgill said that the proposal removes ambiguities: “Its interpretive elements set the grounds for an easy-to-follow compliance checklist and define elements of transparency aimed at organically elevating standards.” He went on to affirm that the need for transparency and clarity is unquestionable in any human endeavour.

Rights On Flights believes this element fills in existing deficiencies and implements improved processes and

ABOVE FROM FAR LEFT:

Kelly Buckland, disability policy advisor at the US Department of Transportation, has been leading on developing a set of disability policy priorities since being appointed in September 2021 by President Joe Biden

Marion Fellows, MP and disability spokesperson for the Scottish National Party at Westminster, has been working with Rights On Flights to hold the UK government to account to get the draft legislation enacted

AATA co-author Josh Wintersgill, who is also the founder of ableMove UK and inclusive innovation programme lead at Open Inclusion

Co-author of the Act, Roberto Castiglioni is director of Reduced Mobility Rights, a member of the UK Civil Aviation Authority's Accessibility Panel and a member of the Experts on PRM Assistance Group of the European Civil Aviation Conference. He also handles external affairs and policy for Rights On Flights and sits on easyJet's Assisted Travel Advisory Board

AATA co-author Sophie Morgan is a BAFTA-nominated TV presenter, producer, writer, disability rights advocate and artist. She was among the first female wheelchair users globally to host a TV show, including live sports like the Paralympics. She has also fronted her own prime-time travel series, as well as numerous current affairs documentaries

Former Labour MP Lord David Blunkett believes legislation is essential “not least because there are so many people experiencing the problems that those with restricted mobility have in terms of the airline and airport experience”

FROM FAR LEFT:

**The fitted seat before conversion to accept the Air4All chair
Controlling the Air4All chair into place before locking at its official launch at the Aircraft Interiors Expo in Hamburg
Testing the Air4All chair at Aircraft Interiors**





“With the support here in the UK, too, and with our consortium and all those who can push it forward, we can finally achieve the holy grail of air travel”

Chris Wood, founder,
Flying Disabled

guidelines to guarantee a fair playing field for all involved, including regulators. Wintersgill continued: “For accessibility, the proposal sets ground rules for the built environment and aircraft environment to ensure the aviation industry becomes fully accessible. This is very forward-thinking about the aircraft environment – something that’s never really been tackled on the accessibility front. There’s been a lot of pressure on airports, and I think if we look at what airports have done over the past ten to 20 years, it has come on. We shouldn’t shy away from the fact that improvements have been made. But society’s perceptions and standards are changing and the industry must change too.” Concerning the aircraft environment, the proposal notes that taking advantage of technological innovation will result in a setting where people with disabilities can maintain their autonomy.

Finally, the Act deals with fairness, as Wintersgill explained: “The proposal sets ground rules for an innovative enforcement model that gives passengers with disabilities certainties while not being solely based on a punitive model. It’s time for the community to not just be part of being consulted or asked to participate, but to be an equal partner at the table.

We must ensure that participation by the community is at the heart of the decision-making process.”

The draft Act states that distinct disembarkation times must be established for single-aisle and twin-aisle aircraft to measure this final pillar. To ensure fairness in the recovery process, a designated Complaint Resolution Official (CRO) – an experienced staff member with the power to address any passenger issues as they occur – will be employed. However, the proposed enforcement process is not draconian, but a two-tiered approach, allowing first-time offenders to learn from their mistakes without facing a penalty.

Wintersgill remarked: “There’s no doubt that when we look back in history, 50 years from now, 2023 will go down as a new beginning for assisted air travel. We hope our proposal will start and serve as an inspiring catalyst, motivating other nations in Europe and beyond to craft robust legislative measures, ensuring safe and dignified air travel for everyone. We are convinced that this proposal should be an essential part of every political party’s legislative agenda since the notions of equality and inclusivity are universal values. We believe that the proposal holds an opportunity that simply



Flying Disabled founder Chris Wood addressing the gathering at the Assisted Air Travel Act launch event

cannot be missed.”

Following the setting out of Definitions and General Provisions in Part 1 of the draft Act, Parts 2-4 respectively cover:

- **Requirements for airports, airlines and tour operators**
- **Training**
- **Complaint handling, reporting and enforcement procedures**

Leading off Part 2 is a requirement for airports relating to accessibility, focusing on planned work at each. It states that an airport managing body “must ensure all future refurbishments and new terminal buildings, including administrative areas and all areas not open to the travelling public, meet Universal Design principles and the relevant national and international accessibility standards.” The need to cater for staff with disabilities is therefore not overlooked. Moreover, each airport has to set up an Accessibility Forum, which must approve every project of this type before work begins.

Certain passenger-facing areas must also meet the same Universal Design and accessibility standards by January 1, 2025, if the Act becomes law this year. These include at least 25% of self-service kiosks (including baggage drop-

offs), e-gates, automated boarding gates, manned counters (including immigration and customs areas), luggage reclaim belts and toilet facilities.

As noted, among the key demands on airlines are those relating to aircraft. For example, aircraft with more than 60 passenger seats, whether fitted with an accessible lavatory or not, must be equipped with an onboard wheelchair. Such wheelchairs must have footrests, headrests and armrests that are movable or removable, adequate occupant restraint systems, a backrest height that permits assistance to passengers in transferring, structurally sound handles for manoeuvring the occupied chair, and wheel locks or another adequate means to prevent chair movement during transfer or turbulence. Each carrier must also provide a sliding board to enable safe transfer from the seat to the aisle chair and vice versa. Regarding accessible lavatories, carriers must ensure all twin-aisle aircraft and all new single-aisle aircraft with more than 125 seats are fitted with at least one, again from January 1, 2025, if the Act is law by then.

When it comes to actually accommodating passengers who wish to remain in their personal mobility aid,

an airline has to ensure that any new twin-aisle airframes are fitted with at least four spaces for such aids that meet airworthiness standards. The same applies to new single-aisle aircraft. These requirements have to be met within three years of the certification date of a suitable anchoring system (more of which later).

For the start of the journey – the booking phase – the Act emphasises the need for autonomy for travellers with a disability. Thus, while air carriers, their agents and tour operators may encourage persons with disabilities to book assistance, they must not require them to do so unless, for example, the traveller requires a personal assistant, is travelling with mobility aids, ventilators, respirators, etc. Importantly, booking assistance requests and the transport of mobility aids and medical-grade devices must be free of charge. Providing information about what is available to these travellers is also vital, so carriers, agents, and tour operators must give consumers access to information about assistance options before the booking process is completed.

At a personal level, there may be times when a person with a disability needs to be lifted from one wheelchair to another or other mobility aids. This assistance must employ appropriate lifting equipment or the person’s equipment. The draft Act insists that under no circumstance, except in emergencies, should a person with a disability be physically carried without the use of appropriate lifting equipment.

All of this, plus the stowage of mobility aids, will deliver huge changes to what the industry has been offering up to now. Rights On Flights hopes and expects other countries to follow suit. According to Kelly Buckland, disability policy advisor at the US Department of Transportation (DoT), they are already working on similar legislation: “We are making efforts in the US to make air travel safe and accessible, because right now, for people who use wheelchairs, it’s neither. I was appointed by President Joe Biden to this position in September 2021 and started developing a set of disability policy priorities that we will implement across the years that I’m here.

“There are four pillars. The first is enabling safe and accessible air travel. The second is enabling multimodal accessibility of public rights of way. The third is around the employment of people with disabilities. And the fourth, but not least important, is ensuring accessibility of automated and electric vehicles.”

Like the Assisted Air Travel Act, the US has proposals for accessible lavatories on single-aisle aircraft and announced a new rule in July 2023. Buckland explained: “There are some parts of that rule that have to go into effect in three years. Onboard wheelchairs are going to have to meet certain standards in the three →



years, but the actual physical space of the restrooms will be required to be accessible in ten years.”

“We’re working on a rule that will ensure the safety of both us and our wheelchairs on aeroplanes,” Buckland added, noting that many people concerned about safety had stopped flying altogether, himself included. “We’re hoping to restore the faith of people who use wheelchairs and those with other disabilities in the safety of flight again.”

Another effort being pursued by the DoT team is making a wheelchair area on aircraft for those who do not want to surrender their mobility device at the door of the aircraft. This is where the US and UK efforts coincide, thanks to a new chair developed by Air4All with the assistance of Delta Flight Products.

Air4All is a collaboration between Flying Disabled founder Chris Wood, Paul Priestman, the former chairman of the PriestmanGoode design house, and Nigel Smith, managing director of certification specialists SWS. They have created a powered wheelchair and locking system that enables a user to use the chair all the way to a position on the aircraft without the airline having to reduce its seat count, something they have long resisted.

“We took the idea to Delta Flight Products in America and they loved it,” said Chris Wood. “They built the prototypes and we launched the system at the Aircraft Interiors show in Hamburg in June 2023. People went mad for it.”

Delta Air Lines has since professed an interest in the chair, Wood revealed: “People say to me: ‘You’ve got the world’s biggest airline interested; you must be well chuffed’ and I say, ‘Not really – I want every airline!’”

Air4All and Delta Flight Products are now pursuing system certification, initially with the FAA. Wood said: “With the support here in the UK, too, and with our consortium and all those who can push

it forward, we can finally achieve the holy grail of air travel.”

He made one caveat regarding The Assisted Air Travel Act: “It seems to be election year everywhere. Parliamentary time is in short supply, so I doubt we will get anywhere before a UK General Election. Still, we will use as many angles as possible to keep pushing.” **AI**

ABOVE LEFT:
Flying Disabled founder and AATA co-author Chris Wood (right) with Leader of the House of Commons, Penny Mordaunt. The draft legislation has received cross-party support in both the Commons and House of Lords

BELOW:
Kelly Buckland, Lord David Blunkett and Sophie Morgan at the launch event for the Assisted Air Travel Act at the Houses of Parliament in London



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The high life

Michael Doran examines the exclusive world of helicopter charters and their luxury machines

When the COVID-19 pandemic grounded most commercial aircraft, airlines and airports went into a financial meltdown. However, helicopter charter services maintained momentum and some sectors even thrived.

In the face of border restrictions and personal health risks, private helicopter services became one of the only viable

options, with one operator reporting 30% growth year-on-year compared to pre-COVID levels. When the top end of your market comprises millionaires and billionaires, cost is less important than flexibility, security and availability.

To get a feel for where the charter market is today, *Air International* spoke to operators in the UK, Greece and Australia, all of whom report that they have never been busier and are struggling to satisfy the high demand levels. [→](#)



PREVIOUS PAGES:
Nautilus Aviation use the H130 to take passengers out to a sand cay in the Great Barrier Reef
 Nautilus Aviation

RIGHT:
The combination of a superyacht and a helicopter gives owners ultimate flexibility
 Airbus

OPPOSITE BOTTOM:
The ACH130 Aston Martin edition is a collaboration between designers at ACH and Aston Martin
 Airbus



The busiest summer ever in the UK

Castle Air has provided bespoke aviation solutions to private and corporate clients for more than 40 years. It covers the whole range of helicopter activity, encompassing charter, sales, acquisition, aircraft management, pilot training and engineering. With five bases spread across the UK, Castle is strategically located to provide easy access to major cities and locations throughout the country and across the sea to Europe and Ireland.

Castle has a significant presence at Biggin Hill Airport, just outside London, which is only a six-minute heli transfer to Battersea Heliport and is close to Heathrow and Gatwick. The company has two state-of-the-art hangars with around 3,000 square metres of space, making the hub well-suited for service and

maintenance activities.

Declan Lehane, Castle's ground operations manager, told *Air International* that the company segments into four main markets: business, shuttle services, special occasions and social and sporting events. Looking back on 2023, he described it as an incredibly hectic time: "Summer was probably the busiest summer the UK rotary market has ever seen, and we had an excellent year with lots of happy customers and repeat business. We increased our AW139 fleet from one to two, and offering a second larger aircraft in the London/UK market was very beneficial for us."

Castle's helicopter sales arm also had a successful 2023, which can impact the fleet available for charter work, with aircraft available for charter until they are sold. After the sale, the new owners may keep the aircraft under Castle's

management and on charter, but with aircraft at a premium globally, others are moved offshore and out of the fleet. As such, fleet numbers fluctuate, but Lehane said it now includes around 12 AugustaWestland AW109s and two AW139s.

The larger AW139s can carry up to nine passengers and are perfectly suited for longer flights from London to Manchester, Edinburgh and Dublin, which Lehane says have become more popular due to a gap in the market for internal domestic jet or fixed-wing traffic: "We've been doing longer flights, and I think a lot of it is down to the fact there's not many G-registered fixed-wing aircraft that can offer the service, while a lot of other registered aircraft can't offer it within the UK. So we've seen an increase in longer flights, and having two AW139s with their performance advantage and size has

Comfort is a must for charters



Castle Air operates luxury charters to special events, shooting trips and European city destinations Castle Air

A great-looking cabin is vital in a VVIP aircraft and helicopter manufacturers like Airbus Corporate Helicopters (ACH) and Bell go to extraordinary lengths to give customers what they want, be it a serviceable cabin to get around on business or an interior that matches

their luxury Mercedes-Benz or Aston Martin cars.

Most owners of VVIP helicopters arrive in luxury cars that increasingly have synthetic leather interiors, including vehicles from BMW, Range Rover, Mercedes-Benz, Porsche, Tesla and Ferrari. When an ACH145 private customer wanted a fully vegan cabin, Airbus met the challenge using synthetic Ultraleather, a polyurethane-based material designed to give the luxurious look and feel of fine hide. The material is tougher than calfskin, offering superior protection from tears and snags while being stain-resistant and easy to clean. So the ACH145 customer got a vegan interior that matched their ethical goals, while Airbus proved that using synthetic materials, including dyes and adhesives, did not impede quality or aesthetics.

In March last year, ACH, in collaboration with Aston Martin, unveiled a new range of external liveries and cabin interiors for its ACH130 Aston Martin Edition. The distinctive and stylish aircraft is a special version of the ACH130 featuring an exclusive range of interior and exterior design features. The luxury car maker said the additional liveries and interiors for the ACH130 have been created to capture the essence of both brands, and its design team is now experienced in applying automotive design techniques to other mediums, from luxury apartments to fine whiskies, motorcycles and helicopters.



Helistar's EC135 is used for both charters and EMS service in the Greek islands HELISTAR

Connecting the Greek islands

Athens and the Greek Islands have long been a magnet for travellers. In summer, even finding a parking spot for your private jet can be as challenging as parking at a railway station during rush hour. Many private jets fly into Athens but can't get landing permission to popular islands such as Mykonos, so they need to make the transfer, which is where helicopter charter specialist HELISTAR steps in.

For more than a decade, HELISTAR has flown high-net-worth individuals and discerning travellers from Athens to Santorini, Mykonos, Naxos and Paros on its luxury helicopters. Those who arrive on private aircraft are unlikely to use a commercial airline or a ferry to make the island connection, so this is one of the areas where HELISTAR has built its business. It has a fleet of two aircraft, including an Airbus H135 and an Airbus Eurocopter H120. However, it has also operated the larger Airbus AS365, which is still listed on its Air Operators Certificate.

The H135 seats six passengers and is a lightweight twin-engine rotorcraft with an effective combination of high-performance and attractive passenger comforts. The H120 is a light single-engine helicopter that can carry four passengers. It is a silent aircraft made using composite materials and fitted with a crash-resistant fuel system and pilot and passenger seats. It is the first helicopter in its class to comply with JAR 27 regulations, and the wide cabin gives passengers panoramic views as they fly out to their island destination.

For HELISTAR, the significant advantage is that a helicopter can land virtually anywhere, including at major international resorts on Mykonos. It allows passengers to transition from their private jet to the resort or their private island hideaway. In summer, there are hundreds of yachts on the Greek islands and most marinas have a helipad, where HELISTAR can land to collect their passengers and take them wherever they want.

really helped us deliver those services.

"Most of our flights are short-haul, whether that's airport runs, airport transfers around the London area or trips to main events like Ascot, Silverstone, Tottenham or the Glastonbury music festival," he explains. "We're seeing a huge increase in higher net worth people going that way as the event aims to attract more VVIPs."

The biggest challenge facing Castle and the UK rotary market is finding enough helicopters and pilots to meet demand over the peak summer season, where most big events happen in one month. With more helicopters in private hands, the pool of available charter helicopters is not big enough for this small window of opportunity, when everybody wants to fly on the same





day at the same time to the same locations.

Castle has developed another strong market niche that fills the quieter winter months in the UK and Scotland. It is a specialist operator for parties on shooting tours, and Lehane says this year's milder winter has been a blessing in disguise. However, around 25% of charters were cancelled due to severe weather in December.

While helicopter charters are often considered the preserve of ultra-high-net-worth individuals or corporations, by 2022

charters were already at around 30% of pre-pandemic levels. Last year brought double-digit growth for Castle's charters, placing even more pressure on the fleet, with airport transfers and shuttle services to London performing strongly. Lehane said: "It is steadily increasing and we're trying to be as clever as we can with it, like planning maintenance for quieter times and spreading it out over the months of January and February. We are really busy at the moment making sure our fleet is ready for what will hopefully be another good year."

From a floatplane to eVTOLs

The rainforest meets the reef in the far north of Queensland, bringing together two of Australia's most iconic tourism attractions: the Great Barrier Reef and the Daintree tropical rainforest. Along with Kakadu National Park, these locations attract tourists worldwide, which is where Nautilus Aviation steps in with its fleet of helicopters.

Nautilus commenced operations in 1993 using a Cessna 208 floatplane, with the first helicopter arriving in 2010. Today, it has a very mixed fleet of around

RIGHT:
Castle Air's Declan Lehane said: "2023 was probably Castle Air's busiest year ever for charter services"
Castle Air

MAIN IMAGE:
Castle Air fly the AW139 on shuttles and luxury charters to special events and European city destinations
Castle Air



40 helicopters used on missions as diverse as tourism, search and rescue, disaster relief, firefighting, powerline inspections, film-making trips and medical evacuations. The fleet includes the Robinson R44, Bell 206, Bell 505X, Bell 260L, Bell 407, Bell 407GXI, Airbus H130 and EC130 types, as well as a Bell 412EP allocated exclusively to emergency services and search and rescue operations. Nautilus has ten bases stretching from Townsville, the gateway to the Great Barrier Reef, to Darwin, the capital city of the Northern Territory.

Nautilus was the first company to operate the Bell 505 in the Asia-Pacific region. Today, it is used on the signature charter service from Cairns to Vlasoff Cay, a picturesque sandbar on the Great Barrier Reef. After around 20 minutes of exploring the tropical waters and glorious sights, the Bell 505 lands on the cay in the heart of the reef, just north of Green Island. Subject to the tide, visitors spend around two hours enjoying a picnic lunch, spectacular snorkelling and swimming, then return to Cairns. Given the pristine environment in which Nautilus operates,

the family-owned business is building its green credentials by ordering ten emission-free electric aircraft from Eve Air Mobility, due to enter commercial service in 2026.

In 2023, Nautilus added five Bell 407GXI six-passenger aircraft to the fleet, which are used for tourism charters, flood relief, bushfire response and utility flights. They are fitted with a Garmin NXi Integrated Flight Deck featuring synthetic vision, wireless connectivity, twin high-res LED screens, moving maps and IFR capability.



RIGHT:
Castle Air fly the AW139 on shuttles and luxury charters to special events and European city destinations
Castle Air

BOTTOM:
Nautilus Aviation uses the Bell 505 for its charters to the outer edges of the Great Barrier Reef
Bell



The Isles of Scilly connector

Since its founding in 1978, Starspeed, a member of the Luxaviation Group, has operated in 65 countries and flown and managed more than 22 different aircraft types from five different manufacturers on five different aircraft registers. Its helicopters have operated in the Alps, the Caribbean and the Greek Islands, to and from superyachts. They also run the Penzance Helicopters service to the Isles of Scilly from Cornwall in southwest England.

Starspeed took over the service from another UK-based operator, Sloane Helicopters, in November 2022 and flies year-round between Penzance heliport and the islands of Tresco and St Marys in the Scillies. The helicopter airlink service forms a vital bridge and has operated since May 1964. The flights are aboard a twin-engine Sikorsky S-76C, which can carry nine passengers, one medium-sized dog or two small ones, as well as cats and other small animals. The S-76 was initially popular for transporting workers to offshore oil and gas

platforms, but has gained more traction in the VIP and corporate transport segment in recent years.

The S-76 is renowned for its resilience and reliability, as well as being well-equipped to deal with the full gamut of weather conditions impacting that corner of the UK. Its large cabin windows give passengers unobstructed views and, overall, the S-76 offers a smooth and comfortable journey for the short flight between the mainland and the islands.

Penzance operates a well-timed morning and afternoon schedule that gives daytrippers around nine hours to explore all that Tresco or St Marys have to offer, with the whole archipelago within easy reach from both destinations.

The heli-yacht partnership

During the pandemic, even the mega-rich had their travelling curtailed, so it was no coincidence that sales of superyachts surged 46% in the first three months of 2021 compared to the previous year. It was not uncommon for those yachts to

come with two essential features: a well-equipped onboard medical facility and a helipad, turning the vessels into their own secure COVID bubble.

The combination of a superyacht and a helicopter gives owners the ultimate flexibility, but things get more complicated when owners or passengers want to use a charter aircraft to land on the yacht at sea. Depending on the jurisdiction in which the transfer takes place, the rules differ, with some regulators treating it akin to landing on an offshore energy platform, while others see no real issues.

Luxaviation knows all about chartering aircraft out to yachts at sea and takes care of all the details to let owners sit back, relax and enjoy the view. The process works exactly as we see in movies, where the helicopter waits patiently for the private jet to land and pull up alongside, with the passengers walking a few metres to board the air-conditioned rotary aircraft. Within minutes, they are on their way to the yacht in a luxury cabin connected to the outside world via digital communication channels.

Whether it's a short trip from shore to ship or an incoming flight from a longer-haul destination, Luxaviation believes there is no quicker way to meet a yacht as it travels worldwide. The company also has the expertise to consult on helideck design and integrating the aircraft while taking into account all the necessary safety and flight training requirements.

Helicopters like the Airbus H145 are also proving popular aboard specially equipped expedition ships on voyages to the polar regions. The big advantage over taking a Zodiac boat to the shore is that the helicopter can ferry guests further inland to destinations only accessible by air for unique activities such as flightseeing, heli-hiking and alpine kayaking. **AI**



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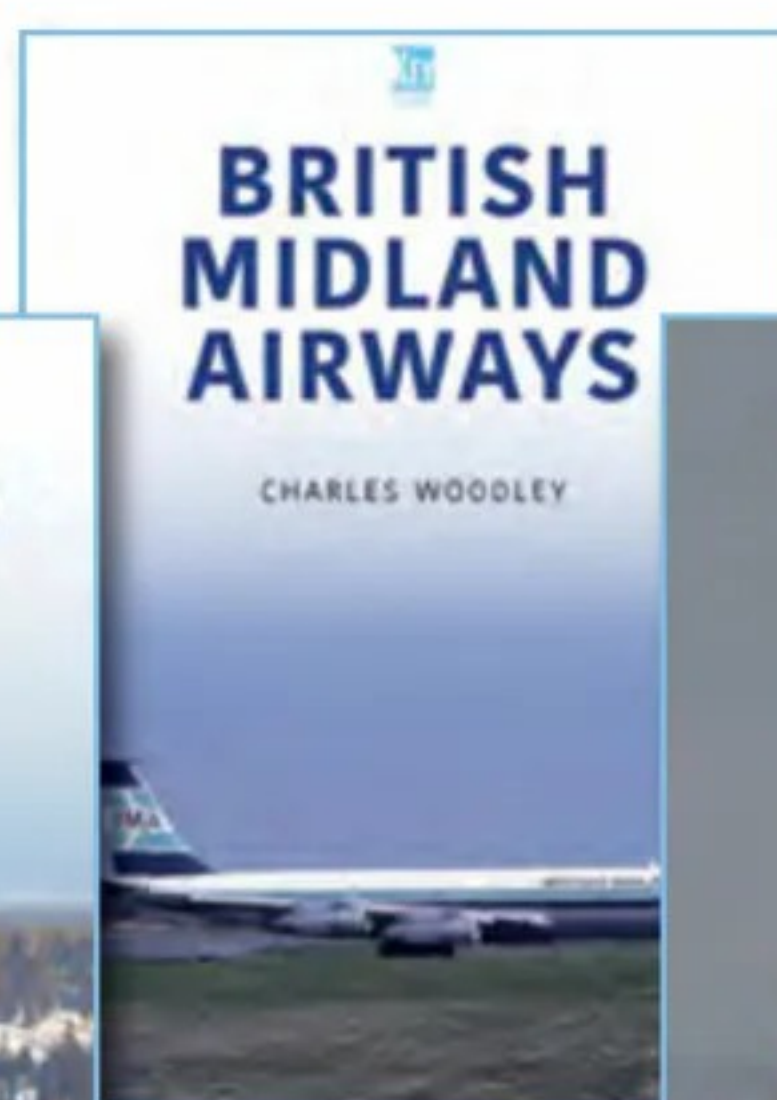
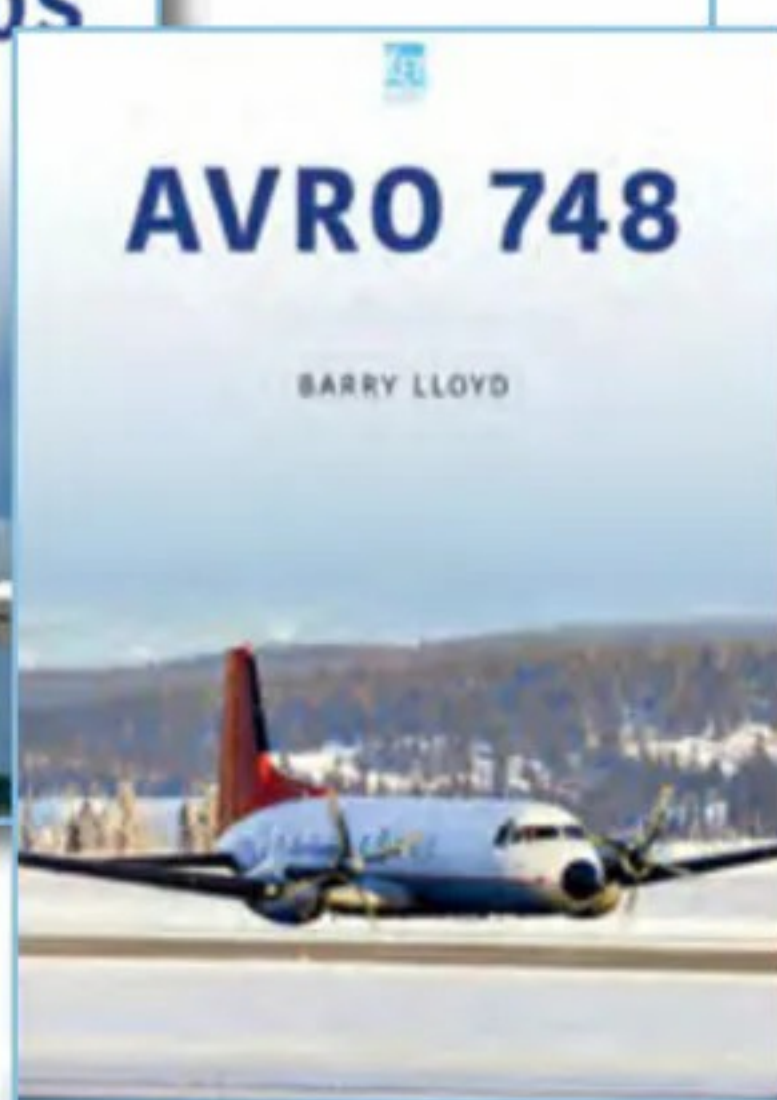
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Whichever rotorcraft wins the US Army's FARA competition will be a platform expected to go deep behind the lines and serve as a network provider, but able strike with precision when needed. Sikorsky believes it has the answer with its RAIDER X.

Glenn Sands investigates

Hit and Run RAIDER

PREVIOUS PAGES:

The S-97 RAIDER has proved itself the ideal platform for Sikorsky to test concepts for its FARA entry – the RAIDER X. The X2 technology used on both platforms has matured and may well prove to be a game-changer for future helicopter development

All images Sikorsky/Lockheed Martin

CLOCKWISE FROM RIGHT:

Sikorsky already sees the RAIDER X seamlessly working with UAVs, whether launching its own or integrating into platforms already in place to gather additional intelligence over the battlespace and beyond

The RAIDER X retains a side-by-side pilot configuration, allowing better crew coordination when in the scout role. The broader cross-section provides for a larger weapons bay within the fuselage



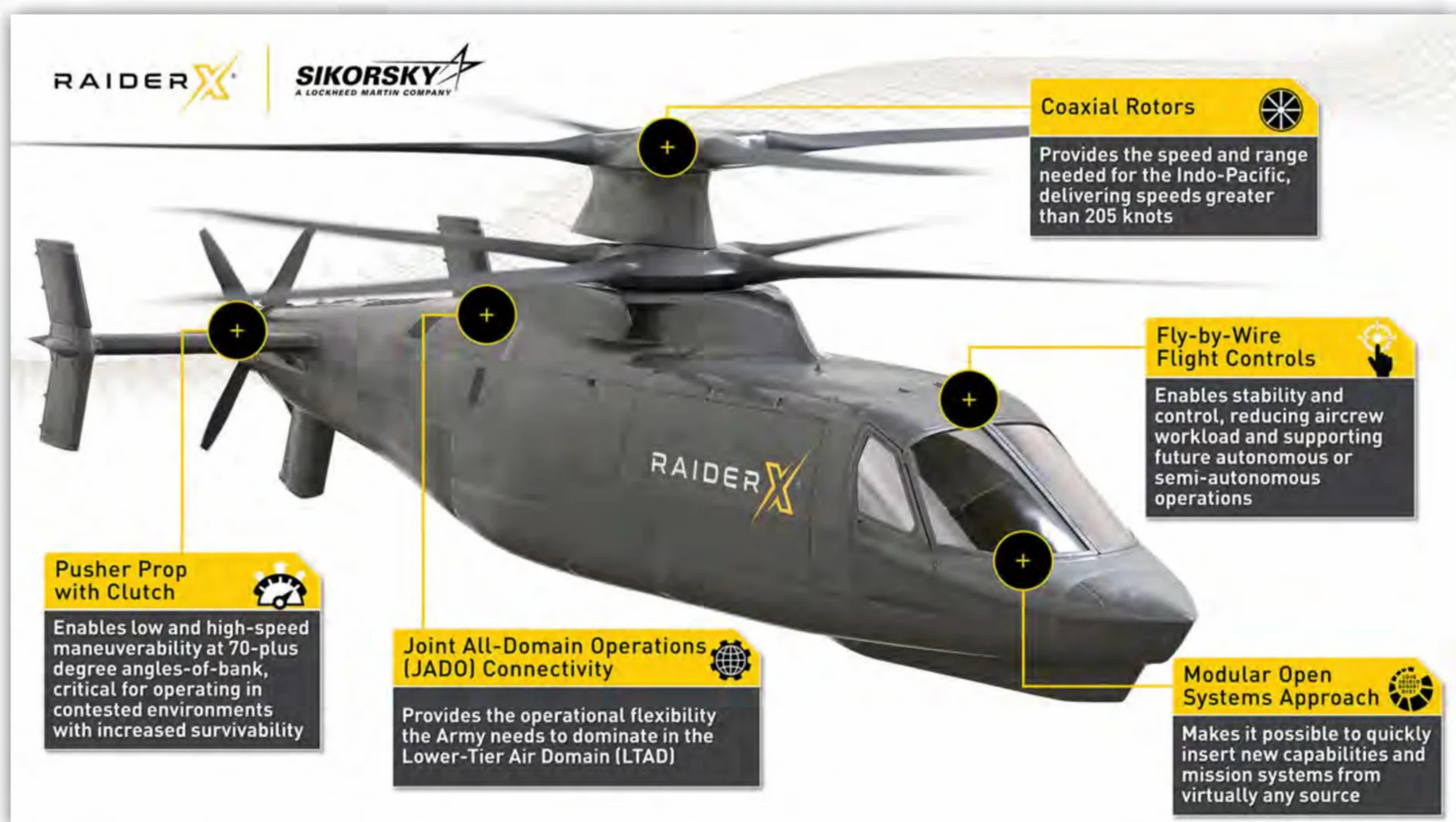
A well-known OEM said recently that helicopter development has reached a stage comparable to when fixed-wing aircraft switched from the propellor to the jet engine. The advanced types that will enter service in the next few years will likely introduce a whole new military doctrine for operating rotorcraft over the battlefield. While it's easy to dismiss such comments as simply hyperbole, the US Army's Future Attack Reconnaissance Aircraft

(FARA) programme proves that significant changes are coming.

For Sikorsky, the stakes couldn't be higher, having lost out on the FLARA programme with their SB-1 Defiant. Despite its cutting-edge technology and performance, it was beaten by Bell's V-280 Valor tilt-rotor design. At present, the choice of aircraft for the FARA competition is still wide-open and Sikorsky is positive it has the winning design with its RAIDER X.

Jay Macklin, director, army, Future Vertical Lift and Innovations Business





Development, said: “As a programme, we’re very excited to be working with the US Army and, as a company, we view FARA as a critical capability.

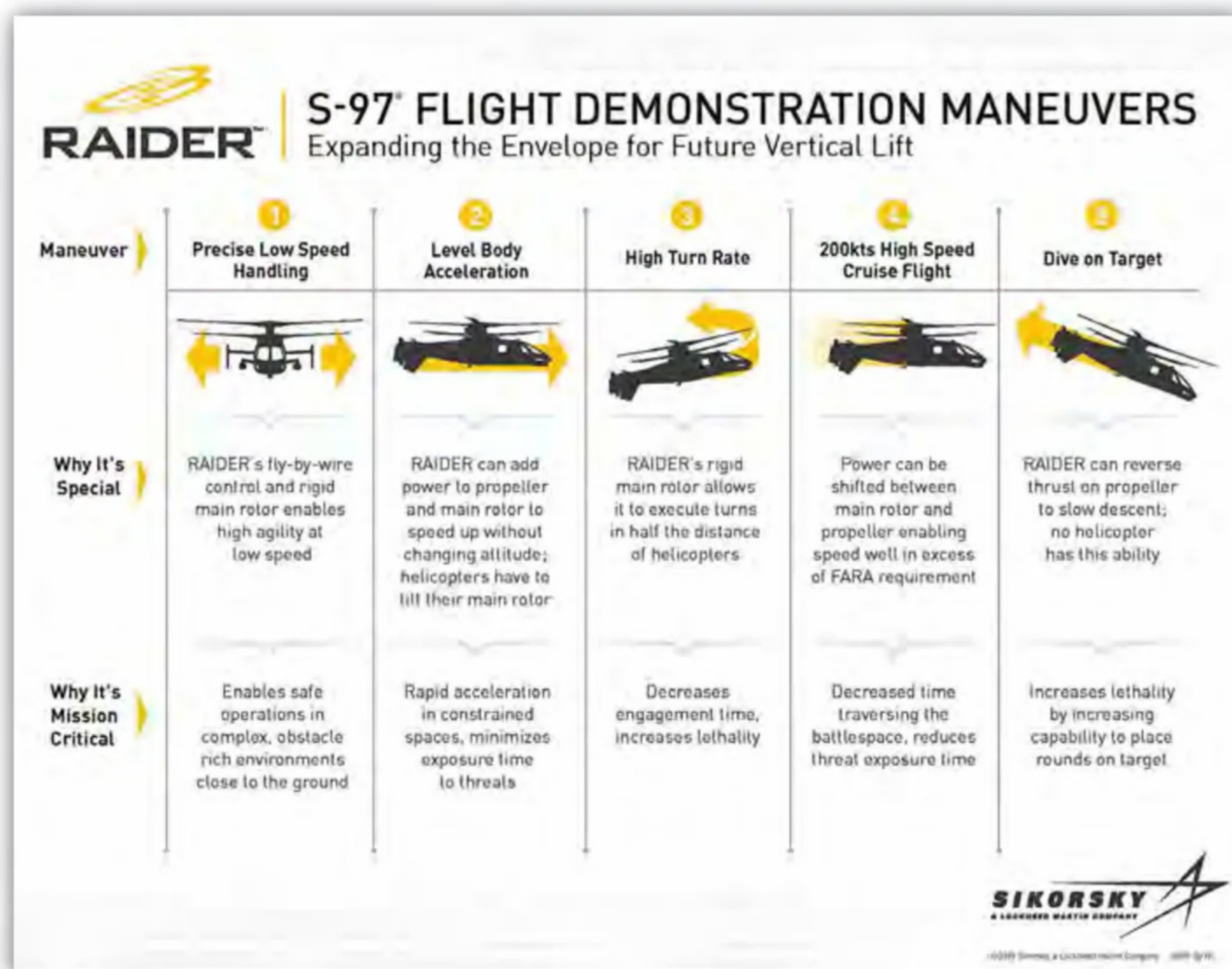
“As a retired colonel with 26 years’ service in the US Army as a Blackhawk pilot, with multiple deployments to Iraq and Afghanistan, when I look at what US Army aviation was doing over there for the last decade, it was a lot of counterinsurgency operations for which aviation is critical. Every ground operation had army aviation associated with it, and if you look towards the future, that’s not going to change.

That’s what the future vertical lift (FVL) programme is all about. It’s looking at the air assets necessary to facilitate success in the conflict. This started in 2014, in Montreal, with the technology demonstrator, which has continued to evolve through the FARA competition.”

The demonstration Macklin referred to is the flight test demonstrator that introduced the hub mounted vibration suppressor (HMVS), a new technology aimed at reducing vibration on helicopters. The demonstration was part of an effort to address the challenge of crew fatigue

and reduced equipment reliability and readiness caused by such vibration. Working with LORD Corporation, the test flight in March 2014 took place at the US Army’s Aviation Applied Technology Directorate (AATD) at Fort Eustis, Virginia, as part of the Active Rotor Component Demonstration (ARCD) programme. The modified AATD UH-60A Blackhawk included progression from a hover to 150kts, auto-rotations and 60° angle-of-bank turns. The successful testing during the flight conditions proved the HMVS reduced vibration significantly, along with a 30% reduction in overall weight.

Macklin continued: “If you begin to look at 2030 and beyond, what are we expecting and what will aviation need? Number one, you have to be survivable. Highly manoeuvrability and speed is a valued attribute to that. You don’t have to look further than the videos from Ukraine showing helicopter operations. They show them operating slower at higher altitudes – it’s not very survivable. I also believe that FARA needs to be connected, as in a complete weapon system. We’re working very hard to provide that because we see the role of FARA in the next decade and beyond to be facilitating that division for corps commanders, shaping that deep fight and facilitating those very far forward manoeuvre elements that are out there. It will be the eyes and ears of the commander a lot farther forward than today. We’ll bring all this capability together in the lower-tier air domain – the lower altitude where FARA will live and use its launched effects. It’s about moving eyes forward and helping feed the information back to those ground





EXPERTS

Former US Army helicopter pilots **Bill Fell** and **Jay Macklin** believe RAIDER X to be the solution for FARA

With all the technology that RAIDER X brings to the FARA competition, nowhere is this felt more than by those who will be test-flying the platform in the next few months.

Bill Fell, a former US Army scout and attack pilot, has been a Sikorsky senior test pilot for 17 years and has

previously flown the JMR-TD, RAH66 Comanche and SB-1 Defiant. Currently flying the S-97 RAIDER, he knows what the platform offers the US Army: “The RAIDER X is a scout aircraft whose primary mission for the modern battlefield is collecting and distributing information and determining where to look and where the priorities are as a situation rapidly evolves. Being out on the frontline, looking at the terrain and getting that human element in the loop is essential.

“I don’t think any of us can really appreciate what tools the scout pilot is going to use by the time the aircraft is fielded, so the MOSA is going to facilitate the rapid integration of whatever tools are necessary at the time or for the threat that they are facing. To assist in this process, the aircraft has large touchscreen displays in the cockpit to help disseminate that information to the people who need it. It adds to the situational awareness that a crew needs. Additional to this information-collecting ability is the X2 aircraft technology with the pusher prop, which means you can completing the mission much faster and at locations that are further away.

“You get a crisp, immediate response from the aircraft – pilots who only fly the simulator don’t get that sensation. The S-97 RAIDER flies much more like a tactical fighter aircraft than a helicopter. It still impresses me whenever I come in to land. I put full reverse on the prop and it’s like a big parachute. The ability to decelerate rapidly reduces the time in the vulnerable state between high-speed cruising and hovering. I think that will improve both safety and the confidence of aviators. Currently, if you want to decelerate rapidly, you bring the nose up

“The S-97 RAIDER flies much more like a tactical fighter aircraft than a helicopter”

Bill Fell, senior test pilot, Sikorsky



30° and bottom out the collective in a helicopter. You just can't see where you're going in this phase.”

Fell had input in the development of the RAIDER X based on the lessons learnt in the S-97, but two things stand out: “One thing we recommended for RAIDER was to use a single collective and outboard sidarm controllers – a very business jet-like layout. The power quadrant in the middle and the fly-by-wire system takes away much of the pilot workload.

“Generally, the pilot in the left-hand seat is the gunner/mission systems operator and the pilot in the right-hand seat is flying. We put this configuration into RAIDER, giving us the more flexibility regarding controlling the pusher prop with only a single collective. It removed having to have two collective levers synched, so we didn't have the complication of adjusting the prop control. There's now a beeper switch to indicate when to decrease and increase prop thrust, and each pilot has their own traditional cyclic and collective, which also provides flexibility as pilots can switch roles if necessary.

“Another change we made with RAIDER X is fitting a tricycle undercarriage to improve ground taxiing, whereas the

X2 demonstrator and S-97 were tail draggers. If you ground taxiing in a rigid helicopter and don't have the prop engaged, you get your thrust from the main rotor. If you push the main rotors forward to increase thrust, the tail wheel comes off the ground. With a tricycle set-up you're just need to compress the forward gear a little and you can taxi with the main rotor. Add nose-wheel steering and RAIDER X will taxi very nicely.” **AI**



ABOVE:

Sikorsky foresees the RAIDER X operating with smaller cavalry units, away from the main force that can maintain, operate and service the platform for extended periods, removing the need for vulnerable large logistical hubs near the warzone

Sikorsky/Lockheed Martin

OPPOSITE:

S-97 RAIDER test pilot Bill Fell has had considerable input into the pilots' needs for the RAIDER X and has been integral in the flying qualities and performance offered by the X2 technology

Sikorsky

LEFT :

Former US Army Colonel and Black Hawk pilot Jay Macklin has had numerous combat deployments to Iraq and Afghanistan behind him. He's only too aware of what RAIDER X can offer the service over the battlefield and far beyond it

Sikorsky



CLOCKWISE FROM LEFT:

The propulsor offers incredible aerodynamic advantages, allowing for deceleration in a dive with a reverse pitch to allow better weapons orientation

Performance of the S-97 RAIDER has been continually enhanced throughout 2023 with modifications to the propulsor and rotor design to increase manoeuvrability and acceleration, all of which have been translated into the RAIDER X bid

Integration of the General Electric T901 engine into RAIDER X was a relatively straightforward process, according to Pete Germanowski, Sikorsky's chief engineer for the FARA programme. The powerplant will also be used on the Apache and Black Hawk fleets

commanders, bringing in space and higher altitude assets such as F-35."

The ability to 'be the eyes' of the commander and relay this information back, perhaps to multiple networks at the same time, will require a certain amount of autonomy with the platform, and Macklin is open to this technology: "At present, there's a lot of talk about autonomy. [Sikorsky] looks at FARA as a kind of pathway to this. With the fly-by-wire system and the autonomous capabilities we have done before allows for the development of introducing this technology now. So, well beyond 2030, when you enter a more autonomous environment, we've already started to pave the way and matured this technology with FARA with a manned asset. However, we believe there's a need for a pilot in the loop, so the network for this capability must be reliable to allow operations to be successful.

"It's very different from when I was flying counterinsurgency, where we flew higher to stay out of small arms range. These FARA aircraft will be flying against near-peer threats in the future, with a sophisticated, integrated air defence network. So it will be able to use its survivability equipment and the speed and manoeuvrability that RAIDER X excels at and contributes to its survival over the battlefield. Being part of that network and facilitating the deep shaping of a division or a corps fight are critical manoeuvres for commanders in the future."

The US Army's operating doctrine for the FVL programme has brought with it a shift in predicting combat engagement areas for its new platforms, expecting it to go beyond the frontline and strike targets at greater ranges than currently undertaken with types such as the AH-64 Apache. This is what the service is calling the 'deep fight'. Macklin explained how this has been one of the core factors in the RAIDER X design: "Obviously, long-range precision fire is a big concern

and, from what we see today in Eastern Europe, this means you've got to push your eyes and ears forward and shape the fight better than ten to 15 years ago. It comes down to the geometry of the battlefield, which has shifted and grown, so you have to project force for longer. These operations in a deeper fight make that close fighting more successful.

"Having an asset like FARA that can move forward in the zone and launch effects further out, extend the





commander's eyes and situational awareness and be part of that entire integrated weapons system is essential. Bringing all of these assets to bear, from the F-35 to HIMARS, is all about situational awareness and a common operating picture. FARA is going to assist in this. It will be out there, collecting intelligence in real-time and feeding into that common operating picture. Using the right sensor at the right time on the right target and then striking that target with the right weapon system. FARA will provide that situational awareness and make a very complex picture smoother for the commander by acquiring that information at a far greater distance."

Mature moves

With the vast potential that FARA will bring to the frontline, Sikorsky is pushing hard with its RAIDER X prototype towards its maiden flight, as Pete Germanowski, chief engineer for FARA at Sikorsky, explained: "The prototype is 98% complete and we have installed the ITEP engine, which is instrumented and ready to go. We're now finalising the last of our acceptance test procedures (ATPs) for all the installed systems. So we're going to be ready for ground runs, which are coming up in the first quarter of 2024. We're currently co-ordinating with the army and the airworthiness authorities to have an exact date."

With so many departments involved with the RAIDER X programme,

Germanowski provided his view as to where each is about supporting the FARA bid: "Regarding the balance of the programme, the preliminary design of the engineering and manufacturing development (EMD) phase involves the production solutions we need, which we are right in the middle of. We have an in-process review coming up in the first quarter, during which we will go through the functional architecture and the design status alongside the army's representatives. This will last several days.

"Following this, we'll continue to mature the design as we get ready for the EMD proposal. That's a full production, weaponised version of the prototype that complies with all of the US Army's requirements for functional architecture. It's designed to be compliant with all of our MOSA requirements and give the army the freedom to rapidly update the system, independent of our involvement, which will be a huge benefit for them from a sustainment cost standpoint, as well as from a lethality standpoint because they can provide capability upgrades much, much faster."

It's clear by the enthusiasm of the design team involved with the RAIDER X, many of whom are former army helicopter pilots, that they know only too well what it will take to survive tomorrow's battlefield. Much has been learnt from the S-97 RAIDER, which was a valuable experimental aircraft supporting the FARA programme bid. However, Germanowski

is keen to clear up some common misconceptions about the earlier RAIDER: "What has to be remembered is that the two aircraft were designed for different mission requirements. The S-97 RAIDER was based on the US Army's armed aerial scout mission. We started that design back in 2012, so well before FARA capability was discussed.

"The biggest reason the two aircraft are different sizes is that the capabilities we were designing differed from those in the RAIDER X, which is designed far more to align with the FARA capabilities. Many lessons learnt from the S-97 have been translated into the RAIDER X design. Much of it comes down to production processes and optimising the design regarding weight and performance. We had the benefit of flying the S-97 RAIDER throughout 2023, to capture specific FARA-relevant performance specification points. We could then take that flight test data and use it to inform all of our physics-based models within a digital environment. This is ultimately a lower-risk proposition than trying to project results only through analysis.

"We've learned how to design the rotor to be more manoeuvrable, and how to design the propulsor to give us additional thrust, which translates into more speed, better acceleration and improved handling. We've learnt a lot about the durability of the design and incorporated features within the platform to provide the army with operational availability →

that supports what they need to do their mission. You don't learn a lot of this until you float the idea out there, which we're benefitting from flying these ideas now."

The benefit for Sikorsky of having what can be viewed as a flying test bed for the RAIDER X ahead of its first flight was enormous, as Macklin pointed out: "For this research and development work to be undertaken, it's our [Sikorsky's] own dollars that we are using to be able to continue to fly the S-97. On every flight hour we are learning something that goes back to reducing risk on that increment proposal that we will put to the army in RAIDER X."

"We think that's very significant in getting the pitch right. You learn a lot of lessons when you build a competitive prototype and light the engine up for the first time. We are significantly beyond that. We're almost up to 145 hours on the S-97 RAIDER and around 160 ground hours. We know the aircraft, which has

helped us learn about our FARA design. It allows Pete Germanowski to translate that information into a design, making it more reliable and effective."

A lot more to MOSA

Reliability and capability to upgrade the FARA winner are critical aspects of the programme, with the US Army keen to avoid the delays and setbacks it endured with its Apache fleet. Sikorsky relies on the digital backbone of its modular open systems approach (MOSA) to allow seamless upgrades without the need for the OEM to be involved.

Germanowski explained: "The first thing we learnt about the MOSA infrastructure was that it extends well beyond the platform itself. We're working with the army to integrate into their long-term vision for how they want to develop and sustain capability across all of their assets. They want to be in a

position where they can drive synergies between aviation assets, ground vehicles and soldier systems. For any of those elements, you need to conform and align with the infrastructure the US Army is putting into place. Again, we've spent a great deal of time working with the service to create the architecture for the weapon system and the capabilities that will be required.

"There are features that you have to incorporate into the weapons system to ensure the capabilities are there for it to be easily adaptable, upgradeable and replaceable. So you're investing up front. But the benefit is when you make a change, you're changing a minor part of the overall system, so it's far easier to implement. And that change becomes portable into similar systems used on a ground vehicle. For me, it's about working more elegantly and efficiently when implementing any upgrade."



Have there been any recommendations from the army during the development stage at Sikorsky? Germanowski said: “We needed to implement some particular software requests and hardware standards. The army provided a functional architecture with which to align our design. It’s about giving them a design they own, with all technical data for them to understand how the design was implemented and how it works. Additionally, we have given them a development environment that will allow them to support their FARA platform.”

Macklin added: “The other real benefit of MOSA, from a sustainment perspective, is the digital design of the aircraft. Its open architecture gives the ability to facilitate upgrades quickly and easily. In the past, if a new radio or black box came out, you’d have to go back to the OEM to make sure you

could add this. That’s a cumbersome and expensive process for the army. MOSA enables this to be done quickly and at a considerable cost saving. The US government is looking for a lot of ingenuity to give them greater capability, faster and more economically. We fully embrace it and believe it’s a significant part of the system. We are trying to be really effective within this operational environment and be part of joint all-domain operations. The four elements that FARA is looking forward to are reach, lethality, survivability and sustainability.

“‘Reach’ refers to long-range precision fire and countering it with transformational speed, combat radius and a significant strategic capability. ‘Lethality’ involves manoeuvrability, agility, a large

cabin weapons bay and operational flexibility or potential multi-role. ‘Survivability’ is that high-speed, really low radar signature and agility. Then there’s ‘sustainability’, which is down to the MOSA. When I was working in army aviation, you’d have to bring all your sustainment together to work on an aircraft, making for a large target in today’s environment.

“FARA is going to be a lot more reliable than the fleets currently out there, and this will come with a high degree of reliability. It will allow smaller portions of the army to move out and split off from each other and still be able to operate, with limited maintenance operating periods. Due in part to the aircraft’s sensing capabilities, it will allow these units and maintenance personnel to have the aircraft effectively ‘talking’ to the sustainer much more than today’s aircraft. It means that ground personnel will know exactly when



The large weapons bay of the RAIDER X is based on a modular launcher system which can be removed of required, allowing the platform to switch to a special operations role and the ability to carry an assault team

Sikorsky/Lockheed Martin



predictive maintenance and routine maintenance is necessary. This entire process is all about increasing the capability of the future ground commander to be successful. But it's got to be affordable, sustainable and produced as part of an entire network weapons system."

The US Army is keen to standardise a common powerplant across all of its helicopter fleets to reduce logistics and keep costs down. The US Army's Improved Turbine Engine Program (ITEP) was critical to this approach, asking the industry to develop a turboshaft engine to provide 50% more power and 25% lower specific fuel consumption while reducing lifecycle costs. General Electric answered the call with its T901 design, which will replace the T700s currently used on all US Army AH-64 Apaches and UH-60 Black Hawks.

First to be equipped with the new powerplant will be the FARA prototypes. Initial issues with receiving the engine from General Electric have led to a slight delay in the overall schedule for FARA. Still, Germanowski is quick to point out that installation onto the RAIDER X is well in hand: "We've been collaborating with the army and GE since 2019, when the ITEP engine was in development. So we'd been following its development closely. When we received it, we had already pre-planned ahead of time with GE and knew all the interfaces for hardware and software and the instrumentation that was being provided for the engine, so we were ready to connect it when it arrived. We had to spend a little bit of time doing our own instrumentation and harnessing runs, simply because we find it more efficient to do these off the aircraft. We made a few minor adjustments to the instrumentation systems and installed them. Honestly, it took one shift to put it into the RAIDER X – it wasn't tremendously difficult. It's simply a case of waiting for clearance from the army to start the engine."

Even at this stage there's talk of the RAIDER X taking on additional roles beyond that of a scout reconnaissance platform. Is there a risk of the crew becoming task-saturated on what will



be a demanding mission over or behind the battlefield? Macklin doesn't think this will be the case: "What we have done at Sikorsky Lockheed Martin is to invest heavily in autonomous capability with the Matrix software, which basically allows you to fly the platform as a regular helicopter, in pilot assist mode or autonomously, similar to an iPad flying the aircraft. We've learned quite a lot from these tests and continue to mature the technology through programmes within DARPA. But I think where this technology comes into play relates to the amount of information coming into the cockpit.

"With multiple launch effects out there, you're trying to feed the common operating picture: you're flying the aircraft, you've got all this information coming in and it can get overwhelming. So we have a version of the 'intelligent co-pilot', which is the ability to get help flying the aircraft and maximise your ability to manage all of the information coming into the cockpit. It's giving the pilots that little bit of help when needed.

"I think this is the pathway to autonomy, having a manned cockpit and learning as the technology develops and the network matures. We believe that the autonomous capability is one of those elements that give pilots the ability to receive and process a lot of information while still being a survivable asset out

over the battlefield and helping them fly. So it's like an intelligent co-pilot – and the FARA could potentially fly autonomously – but you need to be able to operate within a network and it's important to have a human being who's able to take action if the network is compromised and continue with the mission. You have got to leverage the technology but, at the same time, having that person in the loop allows you to execute the mission when other certain things may be jammed."

It's clear from speaking with some of the key players at Sikorsky that the RAIDER X and the technology that it's bringing o the FARA competition is a gamechanger, not just on the battlefield but far behind enemy lines, where logistics hubs, radar installations and supply depots are all open to attack by the US Army, wherever to next conflict might be.

As a veteran of tours in Iraq and Afghanistan flying Black Hawks, Macklin is perhaps best placed to answer how the future fight may look: "For an army division moving forward across the battlefield of the future, they will be trying to paint a picture of the zone they are manoeuvring into, using satellite and higher-chain commands and fixed-wing assets. RAIDER X will be part of those division cavalry units, being the eyes and ears of the ground commanders." **AI**



TOP:
Speed and range will be the cornerstones of the FARA competition, and both bring the ability for the US Army to scout, strike and evade far quicker than anything the service has previously operated
Sikorsky/Lockheed Martin

LEFT:
The S-97 RAIDER has flown around 145 hours and conducted 160 hours of ground runs supporting the RAIDER X programme
Sikorsky/Lockheed Martin

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Soaring to success

Airbus is working on
research and development
of new wing technology
for future aircraft.
Mark Broadbent reports

*The Citation will be an approximately one-third scale model
of the final eXtra Performance Wing*
Images Airbus, unless stated





CLOCKWISE FROM ABOVE:

Test flight: the Citation VII that will receive the eXtra Performance Wing

AlbatrossONE featured the first in-flight, flapping wingtips

Airbus was the lead partner in the German Aerospace Center's INTELWI (Intelligent Wing) project
DLR

In October 2021, the International Civil Aviation Organization committed the industry to achieving net-zero carbon dioxide emissions by 2050. Meeting the formidable target requires work in many areas, from new engines and fuel sources to more efficient operations. According to a 2023 International Air Transport Association development roadmap: “Recent technology assessments for evolutionary aircraft predict another 15-20% improvement compared to the best technology available today.”

Creating lighter, more integrated structures using advanced materials is another key area. This isn't just about using materials such as carbon fibre composites more extensively, but exploring emerging materials (such as graphene or bio-sourced resins and fibres) and investigating new configurations.

Aspect ratio

Improving wing performance can substantially contribute to better aerodynamics and, in turn, an aircraft's efficiency.

The aspect ratio is a wing's thickness relative to its span. Engineers refer to the combination of a short distance between a wing's leading and trailing edges (a short chord) and a long wingspan as a high aspect ratio.

Aircraft with a high-aspect-ratio wing tend to have low vehicle-induced drag, which improves lift characteristics. This efficiency advantage is why gliders have long and narrow wings. Ultra-high aspect ratio wings can also reduce drag by

controlling the boundary layer using flow control technologies.

eXtra Performance Wing

Airbus is investigating new-generation wings with its eXtra Performance Wing project, an initiative managed by the company's UpNext research unit responsible for fast-tracking future technologies that could be integrated into Airbus airliners.

The project's overall goal is testing a wing that can change shape during flight to maximise aerodynamic efficiency and, the company said, “provide multiple wing configurations that dynamically adapt to flight conditions”.

The eXtra Performance Wing will test physical changes to the current wing structure and active control technologies, including gust sensors on the front of the aircraft designed to register changes in turbulence, triggering adjustments to wing control surfaces to improve efficiency.

Hinged wingtips will also be tested to find a configuration that will prevent a future wing from exceeding the maximum wingspan length that can be accommodated by standard airport gates (36m) while changing shape in flight to achieve the desired high-aspect ratio that maximises lift and minimises drag.

Airbus noted: “If the concept is successful and integrated into new aircraft, it has the potential to reduce fuel consumption significantly.”

The eXtra Performance Wing's technologies are a good example of biomimicry, or engineering inspired by

the natural world (see *Air International* October 2023). Sebastien Blanc, eXtra Performance Wing Technical Director, said in November 2023: “The technologies, which change the shape of the wing by mimicking a bird’s feathers, will adjust automatically to maximise aerodynamic flow.”

Cessna Citation

The eXtra Performance Wing will be flight-tested using Cessna Citation VII F-WXWG. Flight tests are scheduled to begin in 2025 after the wing is installed on the aircraft. The Citation undertook its first flight following repaint into a white-and-blue UpNext livery in November 2023.

Airbus explained: “The first flight was an important milestone for the project because the demonstrator is fitted with the exact systems it will have when the eXtra Performance Wings are installed for flight testing. The data gleaned from this and subsequent flight tests will allow Airbus engineers to measure important baseline performance metrics that will be used to determine the impact of the new wing design.”

Once the initial flight testing has harvested enough baseline data, the Citation will be flown to Cazaux, France, where it will be based for the remainder of the project.

Why was the Citation selected as the testbed? The eXtra Performance Wing final design’s targeted wingspan exceeds 50m, so the Citation’s relatively long 50m wingspan (an A320’s is 35.8m) means an approximately one-third scale model of the final design can be tested.

Blanc said: “Things are evidently simpler at a smaller scale. But we chose the Cessna specifically because it constituted the best trade-off between project complexity and representativeness of the final design.”

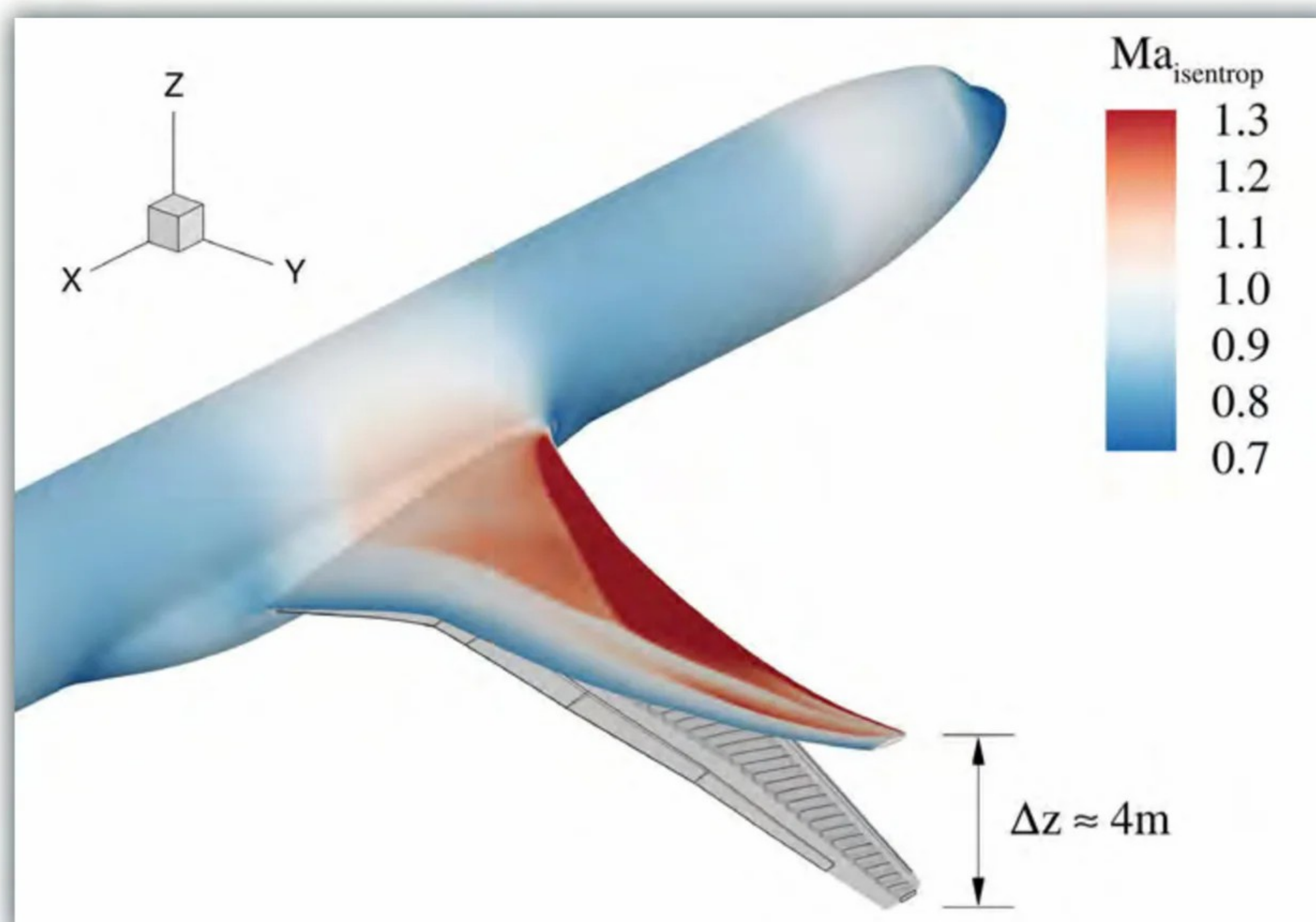
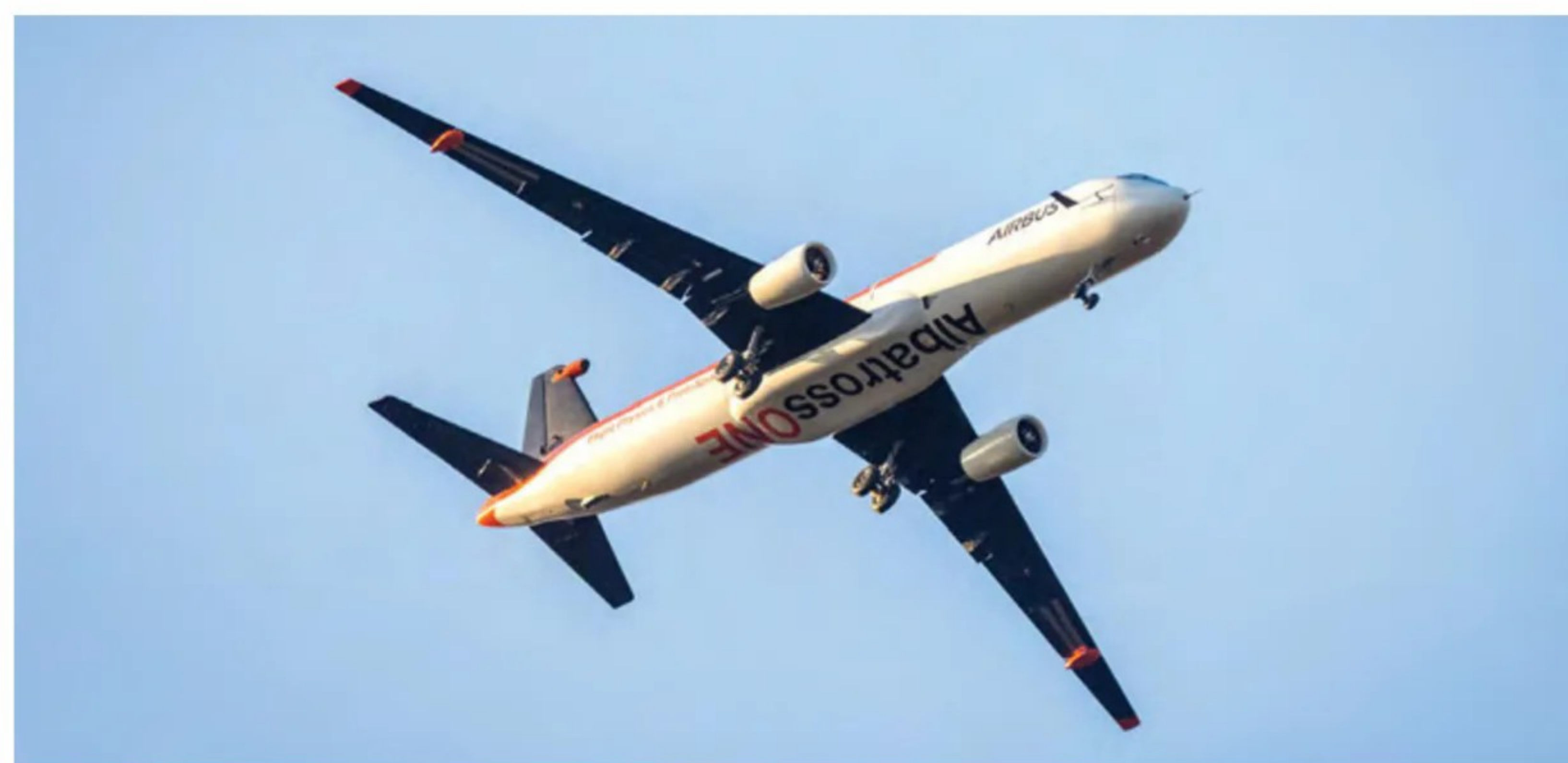
Symbolising the multinational collaboration between Airbus’s four founding nations, the company’s wing research facility in Filton, outside Bristol, manufactures the wing the Citation will receive; Spain will build the folding wingtips; the high lift system will be produced in Germany; and modification of the aircraft will take place in France.

To ensure the concept’s feasibility, a 3D-printed wind tunnel model was tested extensively at low speeds at Airbus’s Filton facility. After the design was finalised, manufacturing of the different wing parts began.

The Citation will be fitted with the eXtra Performance Wing during 2024 and will undergo ground testing before the first flights begin in 2025.

Testing

The Citation flight tests will be uncrewed. A remote operation system will be integrated into the aircraft, followed by flights to test the communication between the 20 antennas on the aircraft and the control centre on the ground. The Citation will be remotely piloted, Airbus explained, “to enable UpNext’s engineers to push the



technologies on board to their limits”.

The company said: “As the Cessna is only a demonstrator and will not be put into production, the decision to have a pilot test the plane from a ground centre instead of on board also alleviates the need to certify the demonstrator for human flight.”

Blanc explained: “We want the flight testing to expose the eXtra Performance Wing to as many realistic flying situations as possible. This will give the different technologies the best possible chance of proving themselves and one day being integrated into the wings of tomorrow.”

Results from the remotely-piloted flight testing will determine the success of the different technologies, but Blanc said: “We have learned so much along the way. We have a real opportunity here to contribute to reducing fuel burn. Just having the potential to change the aerospace industry like this is huge.” ➔



Wing of Tomorrow

A separate wing technology research project at Airbus (although inevitably linked closely to UpNext) is the Wing of Tomorrow programme – the company's largest research initiative in the UK.

Wing of Tomorrow involves producing three 17m-wingspan, full-scale wing demonstrators. The first was a static wing specimen to test structural capabilities and validate the analysis. The second is a fully-equipped demonstrator testing to test installation technologies and novel approaches to equipping systems for next-generation. The third demonstrator will test industrial capability and automation technologies to assess how to scale-up wing production.

Wing of Tomorrow is a partnership between Airbus and funding bodies such as the UK Aerospace Technology Institute, which since 2014 has awarded Airbus £117 million for wing research.

A newly constructed Wing Technology Development Centre (WTDC) at Filton, formally opened in July 2023, is crucial in Wing of Tomorrow. At the time, Airbus Head of Filton site and Wing of Tomorrow Programme, Sue Partridge, said the facility "will help us to ground our research in practicality".

Just ahead of the WTDC opening, the second Wing of Tomorrow demonstrator was completed by Airbus colleagues working in the AMRC Cymru, adjacent to Airbus's Broughton facility in North Wales, and delivered to Filton. The wings are prepared in the WTDC before heading for structural testing in the Aerospace Integrated Research and Technology Centre, which is also part of Airbus's Filton complex.

Partridge said: "It's about preparing our people, technology, industrial system, supply chain and digital and physical capabilities for next-generation aircraft. We're leveraging industry partners and the very best digital tools and automation to identify potential technology bottlenecks that may slow us down in the future. The foundations we lay now will help us build better and faster when the time comes."



AlbatrossONE

In recent years, the eXtra Performance Wing project follows on from (and, indeed, directly feeds from) other wing research and development activities within Airbus. The most notable of these, given the hinged wingtips in the eXtra Performance Wing, was AlbatrossONE.

This was a small-scale, remote-controlled aircraft demonstrator with semi-aeroelastic, hinged wingtips that react and flex in flight to wind gusts. It was the first aircraft demonstrator with such freely 'flapping' wingtips.

AlbatrossONE was developed so Airbus could understand how such a configuration could reduce drag (thereby lowering fuel burn and emissions), alleviate wing loads, avoid tip-stall during landing, increase roll rate compared with fixed wingtips and reduce the effects of turbulence.

AlbatrossONE was another example of

biomimicry in practice. Airbus explained that it "takes inspiration from the flying technique of the albatross, a majestic seabird that can 'lock' its wings at the shoulder to fly long distances with little fatigue".

The company reported: "When faced with wind gusts, the albatross can 'unlock' its shoulder to better navigate wind speeds. Semi-aeroelastic hinged wingtips behave in an analogous way."

INTELWI

As well as its in-house activities, Airbus is listed on the German Aerospace Center (DLR, Deutsches Zentrum für Luft- und Raumfahrt) website as the lead partner in the INTELWI (Intelligent Wing) project.

This ran from 2020 to 2023 and investigated how active and passive load sensors respond autonomously to manoeuvres and gusts to improve efficiency.

A DLR Institute of Aerodynamics and Flow Technology webpage on the project

stated: “An ‘intelligent wing’ is considered to be a consistent next development step for future commercial aircraft and should contribute decisively to securing the future competitiveness of Airbus as an aircraft manufacturer and the system providers as the supplier industry.

“The performance increase and thus significantly reduced fuel consumption of new aircraft is another key objective. The project is based on a number of existing research results, including sensor, control and actuator technology and multidisciplinary simulation methods for wings and combines these in an overall design.”

‘Crossroads’

In December 2023, Airbus reflected on the broader challenges ahead in wing technology. “Today’s engineers face design choices at a crossroads of fuel efficiency, ease of operation and ease of production,” it said.

“For Airbus’s wing makers, the race for low-carbon aviation starts on the ground: in wind tunnels, laboratories, design offices, on the assembly line, around the water cooler.

“The open questions are how far to go and what to favour? What is the best combination of aspect ratio and the span itself? The optimal wingspan for a future single-aisle aircraft is significantly longer than today’s 35.8m. It would require folding wingtips to accommodate taxiway

and gate limitations. How do we design, assemble, test, certify and maintain this substantial design modification?

“The challenge is in locating the sweet spot that maximises value from every angle. Developing innovations is an equation that involves multiple factors: aircraft performance versus industrial considerations versus sustainable cost, for example.”

Airbus continued: “Many impassioned discussions and debates lie ahead. At almost twice the diameter of current turbofans, how would open-rotor engines alter wing design? How would each position affect a wing’s efficiency or its acoustic or vibration profile?

“Unlike today’s aircraft, which store kerosene in the wing, hydrogen-powered aircraft would likely hold cryogenically cooled hydrogen in fuselage tanks. What systems could sit inside a ‘dry’ wing without compromising its weight or performance? What new aerodynamic shapes could a dry wing enable?”

More than 100 technologies are under study in the Wing of Tomorrow programme, Airbus said: “Amid the questions, a picture is emerging. It reveals tomorrow’s wing as just one component of a radical, optimistic and ambitious rethink of how we design and operate the aircraft that will fly millions of passengers towards aviation’s ultimate destination; decarbonisation.” **AI**

CLOCKWISE FROM BELOW:

Airbus UpNext’s Citation rolled out of the paint shop in 2023

Three full demonstrators will be housed at the Wing Technology Development Centre

Filton’s Wing Technology Development Centre officially opened on July 4, 2023

The first Wing of Tomorrow static wing demonstrator on the move from Filton in 2023





Phase III

flying training

tomorrow's most important advanced jet trainers



The advanced jet trainer market is changing rapidly and is becoming ever more hard-fought. **Jon Lake** describes the underlying market situation and looks at some leading competitors

The KAI T-50 Golden Hawk is a family of South Korean advanced jet trainers and light attack aircraft developed by Korea Aerospace Industries with Lockheed Martin. The T-50 is South Korea's first indigenous aircraft and one of the world's few supersonic trainers KAI

Though the retirement of large fleets of long-serving T-38, early Hawk and Alpha Jet trainers has resulted in a hefty requirement for replacements for these aircraft, demand is less than might initially be supposed. In contrast, the potential supply of new trainer aircraft has perhaps never been greater. This makes for a highly contested and complex market.

Older trainer aircraft like the Northrop

T-38 and BAE Hawk (and even the Hongdu JL-8/K-8) have demonstrated extraordinary longevity and remain in service in large numbers – with 576 T-38s (an aircraft that first flew in April 1959), 380 Hawks (1974) and 238 JL-8s (1990). Many will remain in use for many years to come, reducing the opportunity for replacement offerings.

The reliability, availability and efficiency of new trainer aircraft have improved significantly, while the end of the Cold War has reduced demand for new pilots.

Though there has been an increasing use of drones and UAVs, this has not, as yet, had a significant impact on the number of fixed-wing fast jet pilots being trained. The increased use of simulation and synthetic environments has already impacted the demand for 'live' flying, and this trend is only likely to accelerate.

Some air forces once aspired to put most of their new pilots through advanced jet training, 'feeding' their multi-engine and rotary wing streams with the best of those who narrowly failed to make the →

CLOCKWISE FROM TOP RIGHT:

The Pilatus PC-21 is used as a basic, advanced and fighter lead-in trainer, so reducing the number of different aircraft in the training pipeline, delivering better aerodynamic performance, pushing speed and climb rate into the jet domain

Pilatus

The Hawk's cockpit is designed to look, feel and function like the latest front-line combat aircraft. The HUD and full-colour MFDs are supported by the latest generation mission computers, which can provide display data representative of the latest combat aircraft, such as Typhoon and F-35

BAE Systems

At least three competitors are lining up to replace the T-45 Goshawk for the US Navy and USMC. Boeing has already stated that it will refine its T-7A Red Hawk design to meet the UJTS request

US Navy

A broad flight envelope, high thrust-to-weight ratio and 'carefree' manoeuvrability at high angles of attack make the M-346's handling similar to next-generation combat aircraft, maximising training effectiveness and reducing hours on front-line aircraft

Leonardo

The RoCAF will receive 66 AT-5s by the end of 2026. The advanced jet trainer is a replacement for the AIDC AT-3 and F-5E/Fs

RoCAF

grade. This is now uncommon, and many air forces stream student pilots at an ever earlier stage, often after elementary flying training, sometimes after basic training.

The demand for traditional fast jet advanced trainers has also been diluted by the efforts of some air forces to use high-performance turboprops to carry out some (or, in some cases, all) of the syllabus previously flown on jet trainers. France and Switzerland currently operate the Pilatus PC-21 for both the basic and advanced flying training phases, with pilots moving either directly to operational conversion to a frontline type or via a brief lead-in fighter training course.

Switzerland seems to have had some success with its Jetpiloten-Ausbildungssystem PC-21 (Jet pilot training system, or JEPAS PC-21). Its students first undertake three years and four months of airline pilot training, followed by two years of military flight training with 30 weeks on the Pilatus PC-7 Turbo-Trainer and 45 weeks on the PC-21, the latter including 210 sorties. The Swiss have found that the sophisticated training systems of the Pilatus PC-21 enable it to provide training that was never possible on the Hawk/F-5

system previously employed. However, the PC-21's limited engine power (compared with jet trainers) is considered a disadvantage.

The French experience seems to have been less happy. For the French Air and Space Force's Jet Pilots Modernised Training Programme (F21), Babcock and Dassault partnered to deliver 11,000 live flying and 6,500 simulator training hours per year, supporting up to four sorties by some 14 aircraft per day, plus a demanding night flying programme under an 11-year contract. They used 17 Pilatus PC-21 aircraft, two Full Mission Simulators (FMS) and three Part Task Trainers (PTT).

Subsequently, in 2021, the five-year Mentor1 contract was awarded to Babcock to provide an additional nine aircraft, growing the PC-21 fleet by more than a third and expanding the scope of the course to include Fighter Lead-In Training (FLIT). The synthetic setup is reportedly very good, but the programme has encountered difficulties.

Unfortunately, the two fleets are at two different software configurations and are effectively totally separate. The Mentor programme is said to be falling short of





expectations, with the output standard failing to meet the desired input standard for Rafale conversion. Because the PC-21s and their PT6 engines are being used predominantly in the top 5% of their operating envelope, they are experiencing fatigue-related issues, and there is, we are told, some concern that the aircraft may not make it to the contract end.

The French Air and Space Force is seriously examining how the problem might be addressed, including acquiring a dedicated, jet-engined Fighter Lead-In Training aircraft in the shortest possible timeframe. In March 2023, *Intelligence Online* even reported: “Chinese aircraft could be used to train French military aviators.”

While the French and Swiss experience may make further attempts to ‘download’ advanced flying training to turboprop trainers less likely, there is an emerging generation of lighter and cheaper trainer aircraft that could be used for advanced flying training in place of more extensive and more powerful types, further reducing the market for the latter. Some examples of these include the M345, the Aero L-39NG, HAL’s HJT-36 Sitara and the new MiG-UTS, all of which were intended for Basic Training (Phase II), but which could be used for the Advanced (Phase IV) stage. This category of trainer will be covered in a future issue.

There is also a growing trend for air forces to outsource their training locally to industry-run, PFI/PPP-funded consortia or offshore. In the UK, for example, Ascent Flight Training was set up in 2008 as a joint venture between Lockheed Martin UK and Babcock International. It was tasked with designing and delivering a modern and efficient flying training system for the UK armed forces, known as MFTS, essentially using contractor-owned and contractor-operated aircraft, and with mainly civilian ground crew and support staff and a mix of civilian and service instructors. Ascent uses the Hawk T.Mk 2s that had already been procured and the T-6 Texan aircraft that it selected. The trials and tribulations of MFTS were covered in the December 2023 issue of *Air International*.

France has made similar arrangements, with a Babcock/Dassault consortium →



delivering Phase III and Phase IV training using the Pilatus PC-21, as previously discussed. The Hellenic Ministry of National Defence signed an agreement with the Israel Ministry of Defence in January 2021 to establish and operate an international flight training centre for the Hellenic Air Force for a period of 22 years. Elbit Systems provides flight simulators, aircraft training, maintenance and support to the new Hellenic Air Force/Elbit Training Centre. Greece will retire some of its T-2E Buckeyes, adding ten new Leonardo M-346 advanced jet trainers.

While the UK and Greek schools are likely to train modest numbers of overseas students, the Italian-based International Flight Training School (IFTS) is set up to provide training to much larger numbers of international pilot trainees.

The IFTS is run by Leonardo and the Italian Air Force under the auspices of the 61° Stormo, with CAE involved in providing simulators and synthetics.

Initially limited to providing Lead-In to

the IFTS when the M-345 HET (High-Efficiency Trainer, known as the T-345 by the Italian air arm) is fully in service. Italy has signed contracts for 18 T-345s, with an eventual requirement for 45 to replace a fleet of 137 MB-339As and CDs.

Under the final IFTS structure, Phase II and III training will be flown on the T-345 at Galatina, while Phase IV will be flown on the T-346 at Decimomannu.

A similar but smaller operation, the International Tactical Training Centre, has been established by the ITPS (International Test Pilot School) to provide advanced training in London, Ontario, Canada, with its first class of students coming from the Royal Malaysian Air Force (RMAF). The school primarily uses a fleet of upgraded Aero L-39s.

There are also two government-operated outsourced flying training operations in North America.

The Euro-NATO Joint Jet Pilot Training (ENJJPT) Program is conducted by the USAF's 80th Flying Training Wing at Sheppard Air Force Base, Texas. The United States was selected to host the ENJJPT for an initial ten-year period because it combined good flying weather, adequate training airspace, existing facilities and growth potential. Studies on relocation to a European base were eventually abandoned.

The ENJJPT Program officially began on October 23, 1981, based around the 80th FTW, which was already conducting undergraduate pilot training for the German and Dutch air forces. ENJJPT soon included the United States, the United Kingdom, Italy, Turkey and Canada. There are 14 partners, Romania being the latest, which joined in 2016.

Germany, Italy, the Netherlands, Norway and the United States provide instructor pilots based on the number of student pilots from those nations. At the same time, single instructors are also offered by Canada, Greece, Portugal, Spain and Turkey, even though they do not have student pilots in training.

The ENJJPT Undergraduate Pilot Training course graduates about 200 student pilots per year to Wings standard after a 55-week, three-phase training syllabus. About 80 new instructor pilots are also trained each year, and up to 150 pilots transition through IFF Upgrade Instructor Pilot training. There is also an Introduction to Fighter Fundamentals course. ENJJPT is generously resourced, with some 201 T-6A and T-38C training aircraft.

The NATO Flying Training in Canada (NFTC) programme has been running since 2000, using the airspace and facilities of No.15 Wing at Moose Jaw and No.4 Wing at Cold Lake to provide flying training for Royal Canadian Air Force pilots, and for pilots from other NATO partners and allies, including Denmark, ➔



ABOVE:

The TAI Hürjet benefits from the company's experience building and upgrading F-16s and has a configuration similar to that of the Korean KAI T-50 Golden Eagle

Turkish Aerospace

OPPOSITE:

The T-7A Red Hawk is designed around common subsystems with fourth and fifth-generation aircraft to allow for the use of existing maintenance infrastructure, which, in the long term, will simplify maintenance and life cycle costs

Boeing

Fighter Training (LIFT – Phase IV) on the T-346A, the IFTS uses 22 aircraft (18 of them supplied by the Italian Air Force, four by Leonardo) operated by 212° Gruppo, which moved from Lecce-Galatina to Decimomannu.

The school also has two complete mission simulators and three flight training devices and delivers 80 LIFT courses annually, totalling 8,000 flying hours. Qatar, Japan, Germany, Singapore, Austria, Canada, the UK and Saudi Arabia have all signed up to send pilots to the IFTS.

Phase II and Phase III training remain the responsibility of the Italian Air Force for the time being. 213° Gruppo provides initial and basic jet training (Phase II) on the T-339A (MB339A) before students on the fighter and RPA (Remotely Piloted Aircraft) Track progress to the 213° Gruppo for Advanced and Tactical jet training (Phase III) on the FT-339C (MB339CD). Student pilots are awarded their wings on finishing Phase III and then move on to the IFTS. The intention is to embed Phase II and III training into



“The air force had initially expected the T-7A to reach operational capability in 2024, which is now not expected before the spring of 2027”

the UK, Singapore, Italy and Hungary.

The NFTC programme is owned by the Canadian government and operated in co-operation with CAE. It combines basic, advanced and lead-in fighter training as part of a comprehensive pilot training scheme and delivers live flying training on a fleet of Beechcraft T-6 (CT-156 Harvard) trainer aircraft and BAE Systems Hawk (CT-155 Hawk) lead-in fighter trainer aircraft. CAE operates the NFTC base facilities, delivers the ground-school classroom, computer-based and simulator training, and provides support services for the live flying training.

All of the above means that existing in-service trainers are not being replaced on anything like a one-for-one basis, and the global trainer fleet is likely to reduce significantly over time. One estimate is that a global advanced trainer fleet (excluding Russia, China and North Korea) of about 3,200 aircraft today will decline to 2,750 by 2030 and 2,500 by 2040. New aircraft entering service will likely total about 950 aircraft 2020-2030 and 750 in the following decade. Some of these aircraft will be light attack and light fighter variants, with the market for dedicated pilot training aircraft being even more limited. As 351 of the new trainers will be Boeing T-7As for the US Air Force, it seems clear that opportunities for other manufacturers are likely to be relatively scarce and very hard-fought.

And while the demand side of the trainer aircraft equation is set to become tougher, the supply side of that equation is becoming 'looser', and existing manufacturers of advanced trainer aircraft are increasingly finding themselves challenged by new market entrants.

It has been a long-standing tradition for emerging national aerospace industries to follow a similar trajectory – starting off by licence assembling foreign designs before progressing to the design and production of more straightforward aircraft types – often turboprop-powered basic trainers and eventually to more advanced jet-engined trainers, which represent a market segment with fewer 'barriers to entry' than fast jet combat aircraft. Several national industries have been able to develop and manufacture viable and competitive advanced jet trainers, and some of these are now leading competitors in the trainer marketplace, challenging the products of more long-standing producers.

One of the best examples of this is South Korea's KAI T-50 Golden Eagle,



whose development followed that of the turboprop-powered KT-1 Woongbi primary trainer, and which has established itself as a highly-regarded competitor to aircraft like Italy's Leonardo T-346, and Russia's Yak-130. But snapping at the heels of the Golden Eagle are a number of new-to-jet-training manufacturers, including aircraft like Turkey's TAI Hürjet and the Czech L-39NG.

The TAI Hürjet, like the T-50, is an F404-powered, single-engined, tandem seat, supersonic advanced trainer and light combat aircraft; developed based on its manufacturer's experience producing a turboprop trainer (the TAI Hürkuş) and licence production of the F-16, using a broadly similar configuration and structure.

The prototype made its first flight on April 25, 2023, and development is continuing, initially to meet a Turkish Air Force requirement to replace the Northrop T-38 Talon in the advanced training role and to replace the Northrop F-5Es used by the Turkish Stars aerobatic team. Close air support and naval variants may also be produced.

In the future, the biggest threat to T-50 sales is provided by the Boeing T-7A Red Hawk, which is a new, clean-sheet design created to meet the USAF's T-X requirement, for which it was selected over derivatives of the T-50 and M-346, and another new design from Northrop and Scaled Composites, the Model 400 Swift.

As a purpose-built solution to the

T-X requirement, the T-7A met all USAF KURs (Key User Requirements) while being more representative of the latest generation of frontline combat air platforms. As such, the T-7A is one of the only advanced trainer aircraft with a large area display, a state-of-the-art training system with advanced emulation capabilities, and impressive high Alpha handling capabilities.

Saab's innovative model-based engineering also allowed Boeing to beat the rival T-50 and M-346 on price. However, charges on the programme might suggest that Boeing may have underestimated costs and may not break even on the USAF contract.

But the USAF's order for 351 aircraft (of a requirement that could eventually total 475) will allow the T-7A to enjoy significant economies of scale, and the endorsement of the USAF will boost the type's credibility. The T-7A has been designed for maintainability and supportability, and many expect the aircraft to enjoy low operating and through-life costs.

Boeing has said it aims to sell more than 2,700 Red Hawks globally, and the aircraft will be available via the US Foreign Military Sales (FMS) mechanism or by a direct commercial sale. This seems an ambitious prediction, the Teal Group reporting that it was, "difficult to imagine a market for more than 100, and probably fewer, export T-7 trainer models". The ITAR (International Traffic in Arms Regulations) will further narrow the T-7A's potential market, and many potential

customers have already opted for other trainer aircraft. Pricing of any export T-7A is also likely to be significantly higher than the unit cost charged to the US Air Force.

However, two further US requirements could together more than double domestic orders for the type. The US Air Force Reforge Program, due to begin in 2024, could see the procurement of 280 advanced tactical trainers for LIFT, companion, surrogate and adversary training. Under the Reforge plan, students will go from basic flying training to a 12-month Initial Tactical Training (ITT) course on the T-7A. Once pilots complete ITT, they will attend the FTU transition course instead of the FTU basic course. They will do so without first undertaking an Introduction to Fighter Fundamentals course at another base.

ITT-trained aviators only need half the time to qualify for a frontline fighter. They will become a mission-ready flight lead 12 to 18 months earlier than is possible following the current syllabus.

Meanwhile, the US Navy requires 220 advanced tactical trainers to replace its fleet of T-45 Goshawk aircraft after 2025.

The T-7A has already suffered some problems and delays, and the first

production representative T-7A to fly (21-7002, APT-2) did not make its maiden flight until June 28, 2023, and was finally delivered to Edwards AFB, California, for testing in November. The air force had initially expected the T-7A to reach operational capability in 2024, which is now not expected before the spring of 2027.

Boeing is still working through a wing rock issue at high angles of attack, and the escape system has anthropomorphic limits, while there have been suggestions that the aircraft may have a weight issue. The USAF's initial 351 aircraft order for the T-7A puts the achievements of the KAI T-50 in context. The most successful of the current generation of trainers, the T-50 order book (including FA-50s), stands at 280 aircraft. Just 59 of these are advanced trainers for export customers, with 59 more for the the Republic of Korea Air Force (RoKAF).

The T-50 Golden Eagle was developed as a supersonic trainer aircraft intended to prepare RoKAF pilots for the KF-16 and F-15K; it was an indigenous Korean design but one that leveraged KAI's experience building the F-16 under licence and used a similar configuration, with a

similar federated avionics architecture. KAI has produced several advanced, lead-in fighters, weapons trainers, aerobatic teams and light combat aircraft variants using five different radars.

The RoKAF has ordered 50 T-50 advanced trainers, ten T-50Bs for the Black Eagles team, 22 TA-50 armed trainers and 60 FA-50 light combat aircraft. Outside the Korean domestic market, the Golden Eagle has proved more successful as a light combat aircraft (with 84+ export orders) than as a pure trainer (28+ export orders).

The T-50 has an excellent training system but is expensive (reportedly costing more than the BAE Hawk), and its use of an F404 engine and other US systems makes it potentially vulnerable to US sanctions. One planned sale to Uzbekistan has already been blocked.

The T-50's main competitor as an advanced training aircraft has been the Leonardo M-346 Master. The M-346 has an unusual back story, as an Italian derivative of the Soviet Yak UTS. Development of the Yak UTS began in 1990 to meet a Soviet requirement to replace the L-29 and L-39, competing against the Mikoyan MiG-AT. Following the collapse of the USSR, Yakovlev teamed with Italy's Aermacchi in 1993 to develop the aircraft jointly as the Yak/AEM-130. The first Yak-130D prototype made its maiden flight on April 25, 1996, but the partnership then foundered, and the two companies pursued the development of separate derivatives of the original Yak-130D. This led to the development of today's M-346, a thoroughly Westernised derivative, which conducted its maiden flight on July 15, 2004, with Honeywell F124 turbofan engines and a digital flight control system developed by Teleavio, Marconi Italiana and BAE Systems.

In some respects, the M-346 represents the polar opposite of the eye-wateringly expensive, high-performance, highly combat-capable T-50. Though Aermacchi, Alenia and Leonardo have developed a number of armed M-346 variants, the aircraft is better optimised as an advanced trainer and has been somewhat more successful as such, with an order book for 135 trainer variants alongside just 18 light combat aircraft



ABOVE:

In February 2014, Poland chose the M-346 as a successor to the TS-11 Iskra training aircraft. The country has a fleet of 16 M-346 aircraft after Leonardo delivered the third and last batch of four jets in mid-December 2022

Leonardo

OPPOSITE:

The USAF's Pacer Classic programme initiated in 1984 introduced a series of upgrades to the T-38 fleet to extend the life of the trainer until at least 2030, by which time the T-7A Red Hawk will be replacing the Northrop classic

USAF

versions. Despite its twin-engined configuration, the M-346 is said to enjoy 20% lower Maintenance Man-Hours per Flying Hour (MMH/FH) than the T-50, with superior agility, excellent handling and superior high Alpha characteristics, and a better view forward for the instructor in the back seat. Leonardo claims it offers the most advanced training solution and significantly reduces costs (up to 50%) for a student pilot to qualify as combat-ready on a latest-generation fighter.

Though its acquisition cost is higher than some of its rivals, the M-346 enjoys relatively low costs of ownership and effect, and its roster of customers includes several 'reference air forces' including Italy, Israel, Poland and Singapore, as well as the various users of the ITFS.

The M-346 lacks an afterburner, but most air forces consider it fast enough for a trainer, though it has sometimes lost out to the T-50/FA-50 when more 'muscle' is required.

Although Poland bought the M-346 as a trainer, it selected the FA-50 when it needed a light combat aircraft.

Some 82 M-346s are in service with five countries, with a further 14 aircraft on order, including an order for ten from Greece.

The Yak 130 was the Russian derivative of the joint Russo-Italian Yak/AEM-130, optimised to meet Russian requirements for an advanced pilot training aircraft. The aircraft was intended to replicate the handling characteristics of frontline fighters, with a four-channel digital Fly-By-Wire flight control system, open architecture digital avionics and a fully digital glass cockpit, at roughly half the price of its Italian counterparts. About 66 were exported to Algeria, Bangladesh, Belarus, Laos and Myanmar, but further exports will be made more difficult following sanctions imposed after Russia's occupation of Crimea in 2014 and its subsequent invasion of Ukraine.

The Chinese Hongdu L-15A Falcon (or JL-10) is not, technically, a derivative of the Yak-130. However, it has a similar configuration, and the Yakovlev Design Bureau served as a technical and scientific consultant for the L-15 programme. The L-15B, a supersonic variant with afterburning engines intended for LIFT, was announced in 2010. This formed the basis of subsequent light combat aircraft variants. Six fighter variants have been delivered to Zambia, and the UAE has ordered 12 for aerobatic team use, with 36 options for possible use as trainers. Ethiopia has also ordered the type.

The Guizhou JL-9, also known as the FTC-2000 Mountain Eagle, was developed by the Guizhou Aviation Industry Import/Export Company (GAIEC) as a competitor to the JL-10/L-15. Based on the F-7 airframe, the JL-9 is a two-seat supersonic advanced jet trainer and light combat aircraft, and it is marketed as one of



Based on experience in the M-346 programme and aligning with the most advanced standards for fighter aircraft, Leonardo's M-345 includes avionics and a state-of-the-art man-machine interface. At the same time, the Embedded Tactical Training System (ETTS) permits the reproduction of complex tactical scenarios during training flights

Leonardo

the cheapest light fighters available. Small numbers have been delivered to the People's Liberation Army Air Force (PLAAF) and the People's Liberation Army Naval Air Force (PLANAF), with six FTC-2000Gs exported to Myanmar and five to Sudan.

The L-15A and the Yak-130 seem to cost about half the price of the T-50 and M346, while the JL-9/FTC-2000 is even cheaper!

Taiwan's AIDC T-5 Brave Eagle is unlikely to be exported but is, in any case, unlikely to be incredibly cheap. The Republic of China's Advanced Jet Trainer (AJT) Program began in the early 2000s to produce a replacement for a fleet of AIDC AT-3s and Northrop F-5s used as advanced trainers. Four main options were considered: a modernised, upgraded version of the AT-3 (the AT-3 MAX); a derivative of the AIDC F-CK-1 Ching Kuo indigenous defensive fighter (the XAT-5, then known as the Blue Magpie); a licence produced

version of the Italian Alenia Aermacchi M346 Master; and the South Korean KAI T-50 Golden Eagle. After initially seeming to favour AIDC assembling the M-346 in Taiwan, the XAT-5 was selected, with the delivery of 66 aircraft then scheduled to begin in 2026. In the event, development was rapid and the first of four prototypes made its maiden flight on June 10, 2020, with production deliveries beginning on November 28, 2021, and mass production starting in March 2023. The T-5 has 55% indigenous content and enjoys excellent performance – with an indigenous AESA radar and formidable (if latent) operational capabilities.

There are a number of advanced trainer aircraft programmes that remain some way short of flying, even in prototype form. These include India's HAL HLFT-42, Airbus (Spain) AFJT and the UK's Aeralis Modular Trainer, which will be fully explored in a future issue of Air International. **AI**



Supplies on call in Ant



arctica

Tom Batchelor spoke with Windracers, which has ambitious plans to operate its UAV in one of the world's most inhospitable environments in support of research

Global warming is changing Antarctica in ways that will impact the entire planet. With declining biodiversity and melting ice sheets triggering a global rise in sea levels, the need to study and understand the full effects of the changing climate on this fragile continent has never been more urgent.

The Cambridge-based British Antarctic Survey (BAS) has been responsible for most of the UK's scientific research in Antarctica for the past 60 years. Until now, they have relied on a fleet of five aircraft to help their teams undertake scientific and transport missions. But the challenges involved in reaching remote parts of the continent, coupled with the region's extreme and often unpredictable weather, mean the traditional technology used for this vital work is not always capable of fulfilling each mission.

Which is why BAS has partnered with UK cargo drone developer Windracers to test its ULTRA (Uncrewed Low-cost TRANsport) platform in Antarctica during the southern hemisphere's upcoming summer season. The hope is that the ULTRA drone will unlock year-round scientific study at lower costs and have a reduced carbon footprint compared with the de Havilland Canada Twin Otters and Dash-7 that BAS has in its fleet. The ULTRA UAV will be heading south in time for its inaugural flight in January 2024, and will be based at Rothera Research Station, the centre for BAS air operations, which has a 900m crushed rock runway, apron, hangar and fuel storage tanks.

Stephen Wright, co-founder and chairman of Windracers, said the partnership with BAS was the culmination of seven years' work. Speaking at the launch event in Cambridge in October, he said: "To be out there involved in the science is terrific. We have developed this [aircraft] deliberately from the start to be able to carry a large payload of 100kg over 1,000km. It allows us to do the exciting science that BAS has planned out in the Antarctic."

BAS is seeking to automate its science platforms and reach net zero carbon emissions by 2040, with the ULTRA drone a key part of that strategy. ULTRA will be deployed for a number of ➔

Utilising a twin-boom design and having a maximum take-off weight of 450kg, the ULTRA UAV can operate from grass, dirt, or ice-strips as short as 100m, with oversight from the ground operator

Windracers



missions, including surveys of protected and environmentally sensitive areas and assessing the marine food chain (krill) using cameras, investigating tectonic structures with magnetic and gravity sensors, assessing glaciological structures using airborne radar and testing an atmospheric turbulence probe for studies of boundary layer processes coupling ocean and atmosphere.

‘Next giant leap’

Aviators have been experimenting with flight in Antarctica for more than a century. The first voyage was on February 4, 1902, when British explorer Robert Falcon Scott ascended above McMurdo Sound in a gas-filled balloon, then the first powered flight took place

in 1928 when Australian George Wilkins completed a 20-minute trip in his high-wing monoplane. More than a quarter-of-a-century later, the first large-scale British aerial survey in Antarctica took place in 1955, when the Falkland Island Dependencies Aerial Survey Expedition (FIDASE) used two Canso amphibious aircraft and several ship-borne Sikorsky helicopters to map 90,000km² of terrain. The second half of the 20th Century has seen a variety of aircraft put to use in the extreme Antarctic climate, including the ski-equipped Basler BT-67 and LC-130 Hercules and C-17 military transport planes.

Carl Robinson, head of airborne survey technology and remotely piloted aircraft systems (RPAS) at BAS, told

Air International that the introduction of UAVs is the “next giant leap” in airborne discovery of the icy continent: “The ULTRA opens up that airborne capability at any time of year, to be able to use it in areas where we can’t physically have an aircraft, such as islands and other places without large-enough runways.”

“Polar regions are one of the areas of the world that are changing the fastest and the most significantly as the climate changes,” said Tom Jordan, an aero geophysicist at BAS. “The job of a polar scientist is to understand these changes. These observations feed through into the models, and the better those models are, the better our forecasts and predictions about what is going to happen in the future will be.”



CLOCKWISE FROM ABOVE:

The Windracers ULTRA UAV on approach to Llanbedr’s main runway after a local test flight over Wales Windracers

At present, the BAS relies on aircraft such as the Dash-7 to re-supply their scientific sites, which comes with the inevitable carbon footprint BAS

The ULTRA has a 700-litre cargo bay that can house sensors for collecting environmental data in the Antarctic region, which can include an ice-penetrating radar for survey flights Tom Batchelor

Robust and versatile UAV

Crucially for the BAS assignment, ULTRA is both robust and versatile. The fully autonomous, twin-engine, twin-boom, ten-metre fixed-winged aircraft can take off, fly and land on grass, dirt or ice, in as little as 100m and with minimal ground operator oversight. With an empty weight of 300kg and a maximum take-off weight of 450kg, it also benefits from a sophisticated autopilot system called Masterless developed by Distributed Avionics. The modular vehicle is fitted with a 700-litre cargo bay that can be modified to house different payloads, as well as a wide range of sensors for collecting scientific data, including radar capable of penetrating through 1.5km of ice. It has 24 interchangeable control surfaces, fuel-injected four-stroke Vanguard engines from Briggs & Stratton, a triple redundant flight control system and a highly segmented control strategy with a local actuator node



controlling each actuator.

"We are able to tolerate quite a few failures and keep going," said Tom Reed, the flight software lead and test pilot for Distributed Avionics, who will help co-ordinate the project from Rothera.

ULTRA's complex flight control system includes automatic deconfliction with other ADS-B enabled aircraft, and an ability to take information from traffic, weather and terrain servers and process this information for rerouting. The entire process can be supervised from a command centre in the UK, reducing the time, cost and carbon associated with transporting crews to Antarctica. Additionally, it does not require ground infrastructure and has been designed to fit in a 20ft container, with the wings and tail detaching to facilitate transit.

The project is being funded by Innovate UK's Future Flight 3 Challenge and is part of its pilot programme called 'Protecting environments with uncrewed aerial vehicle swarms', aimed at demonstrating how advanced drone technology can be used to gather environmental data in the region. With AI-driven SWARM technology, multiple ULTRA drones will be able to organise themselves into a single unified system to collect science data across a larger area when paired.

Although alternative propulsion systems were considered, the Windracers team ultimately opted for a conventionally powered UAV. Speaking to *Air International*, Reed said: "We have good fuel economy, good range and are able to take a meaningful payload. Electric propulsion systems and batteries for this size of aircraft are ferociously expensive, and these commercial off-the-shelf engines are really quite a cost-effective option."

Dubbed the 'Jeep of the Skies', the ULTRA platform is a rugged but lightweight aircraft, 95% of which is fabricated from damage tolerant and inexpensive aluminium alloy. Windracers sources parts from an Indian supplier, but the final assembly is completed in the UK, as is the design, development and manufacture of the Distributed Avionics flight control systems.

The platform incorporates a high level of redundancy, and the decision to equip it with two engines was made early on in the design process. Reed explained: "You can go through every design assurance certification practice out there to assure yourself that your single engine will never break, but it is incredibly hard to match the level of inherent fault tolerance and

robustness of having a twin." Indeed, the ULTRA can continue to fly even if one of the engines or components is damaged or fails.

The ULTRA platform is also suited to the extreme environment in which it will operate. Reed said it had been put through a weather testing chamber to evaluate its performance at -20°, -30° and -40°: "That was really insightful. There is some light de-icing capability built into the aircraft – for example, the pitot tubes are heated – and we put an oily coating over the wing's leading edges to delay ice formation. The leading edge is also not covered in rivets and rough surfaces, so there are no nucleation sites for ice to form, but this is all prevention rather than cure."

The precise performance characteristics of the ULTRA, including →



its ability to land on compacted snow, will be tested in the field. Snow and ice are a hazard associated with operating in Antarctica, but Rebecca Toomey, a ground control station operator with Windracers who will also be making the long journey south from the UK with the UAV, said: "With Rothera being quite a dry place, it is unlikely that we are going to encounter icing conditions. However, we are going to be working closely with the Met Office and the meteorological forecasters in the area to plan our mission to avoid these conditions. ULTRA has been designed to fly in rough weather conditions, it is a rugged platform, and it is designed to take off and land from unprepared runways."

The UAV will enable BAS to gather a broader range of data at lower cost and improved safety, without the inherent risks to crews from the extreme operating environment. IT will also extend the window for collecting that data to the winter months when perpetual darkness and very cold temperatures prevent flying with the existing piloted fleet.

Complementing the Twin Otter

The current BAS fleet consists of four de Havilland Canada Twin Otters, equipped with skis for landing on snow and ice, and one de Havilland Canada Dash-7. The Dash-7 and three of the Twin Otters have been modified to allow them to carry out airborne science surveys. This small fleet requires an aircrew of eight pilots and four engineers, who must ferry the aircraft into position in Rothera for the start of each flying season.

The Dash-7 is put to work on shuttle flights from Rothera to the Falkland Islands and Punta Arenas in Chile, and BAS aircraft also operate out of Halley Research Station and from Fossil Bluff and Sky-Blu Field Stations. One of the Twin Otters is based at Halley to support projects in the eastern sector of BAS operations, covering an area up to 800km from the station. In winter, the aircraft return to the northern hemisphere for major servicing and overhauls.

BAS has experimented with more rudimentary drone technology in the

FAR RIGHT:

During a typical season, the aircraft transport people, fuel, skidoos, sledges, food and scientific equipment to remote camps. The ULTRA UAV may take over some of these support flights in the future
BAS

MAIN IMAGE:

Rothera Research Station is the most significant British Antarctic facility, the centre for biological research, and a hub for supporting deep-field and air operations. It's located on Adelaide Island to the west of the Antarctic Peninsula
BAS



past. Researchers used the commercially available quadcopter DJI Mavic 2 Pro to monitor populations of seals, penguins and albatross in South Georgia and the South Sandwich Islands. The team has separately used fixed-wing drones, capable of operating autonomously beyond the standard visual line of sight, to survey major elephant seal colonies around South Georgia.

Windracers' ULTRA has the potential to scale up the airborne science done by BAS, with an increase in geographic coverage and the possibility of round-the-clock operations. The UAV is also considerably cheaper to run, with a fuel consumption of around 11 litres per hour, compared to 300 litres an hour for the Twin Otter.

But BAS has been clear that the ULTRA is not intended as a replacement for the piloted fleet. Robinson, who will be travelling to Rothera as part of the inaugural mission, said: "There will be days when the Twin Otter is the right platform, for example because we have big experimental equipment that needs somebody in there with it."

Two of the four BAS Twin Otters have dual magnetometers – instruments used to measure the strength and direction of a magnetic field, which helps identify different rock types – and a radio echo sounder that is used to bounce radio waves through ice to determine its thickness. The aircraft can measure 5km beneath the surface of the ice, a greater depth than the ULTRA, and has a higher payload capability, speed and range. Jordan noted: "We are in the planning process of getting an 150 Mhz radar that can actually do full depth sounding down to a scale that we can put on the Windracer."

The teams at BAS and Windracers are hopeful that a successful trial at the beginning of 2024 could redefine how aerial surveys are done in Antarctica. Wright said: "Ultimately we want to have a number of these based out of Rothera, where they are given a mission from the UK to go off and do some science. They will start up, take off, fly, do the science, come back and land on their own. Then, we will be in a completely different paradigm." **AI**



It can stress people out, the boarding experience.” So said Carolyn McCall. In 2012, the then easyJet Chief Executive introduced allocated seating for a fee.

This stress-induced experience has been on the rise for decades.

Before 1970, the average boarding speed of passengers was approximately 20 passengers per minute. Since 1970, however, the speed at which passengers boarded an aircraft (aircraft rate) had slowed by more than 50% to as low as nine passengers per minute.

It’s a picture acknowledged by Southwest Airlines, with a spokesperson sharing, “When we first began flying in 1971, and until the mid-2000s, boarding positions were given out at the gate and only on a first-come, first-served basis. Our customers were known to wait for sometimes longer than our then primarily short-haul flights to be among the first onboard.”

It’s not just passenger convenience that’s at stake. Airlines are under increasing pressure to improve profitability, introducing new aircraft with higher passenger loads and maintaining fleets in revenue service as much as possible. According to the American Trade Association and lobbying group Airlines for America, in 2022, the average cost of aircraft block (taxi plus airborne) time for US passenger airlines was US\$101.18 per minute.

Delayed aircraft are estimated to have cost the airlines several billion dollars in additional expenses.

Assuming \$47 per hour as the average value of a passenger’s time, flight delays are estimated to have cost air travellers billions of dollars. The Federal Aviation Administration (FAA)/ National Center of Excellence in Aviation Operations Research (Nextor) estimated the annual costs of delays (direct cost to airlines and passengers, lost demand, and indirect costs) in 2018 to be \$28 billion.

A way an airline can mitigate these costs is to reduce aircraft turn time. The turn time includes:

- **Arriving at the gate**
- **Deplaning**
- **Unloading bags**
- **Cleaning and restocking the aircraft**
- **Boarding & loading bags**
- **Leaving the gate**

For many airlines, the most significant factor in turn time is the passenger boarding process, but things haven’t improved, with boarding times increasing by up to two minutes since 2019.


What a carry-on

In 1998, Boeing attributed the trend to increased passenger carry-on luggage, more emphasis on passenger convenience, passenger demographics, airline service strategies, and airliner flight distance (stage length).

Twenty-five years later, John Milne, an Associate Professor, Engineering & Management and Neil ’64 & Karen Bonke Endowed Chair at Clarkson University in New York, believes there are at least two contributing factors.

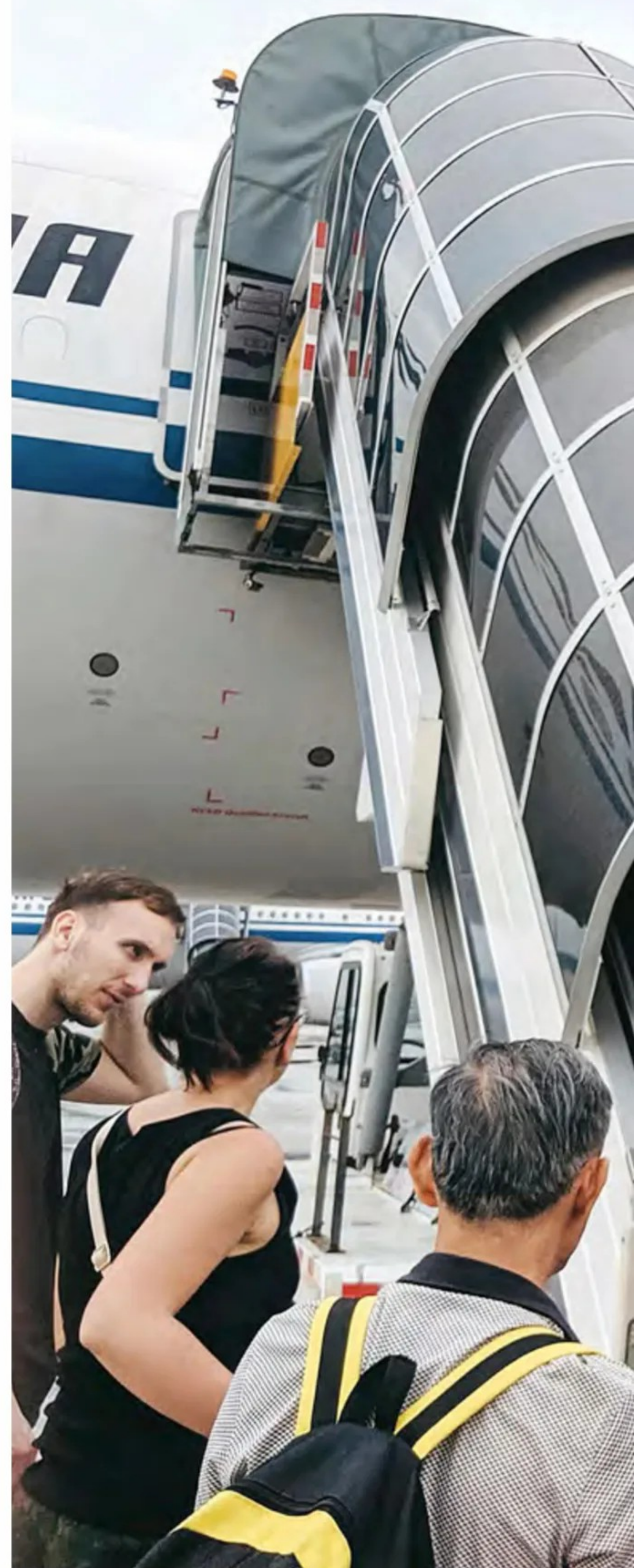
First, fees to check luggage, which Milne says incentivises passengers to bring more carry-on luggage into the cabin. “And they need time to store luggage,” he emphasises.

Secondly, there is an increased number of boarding groups based on passenger status (how much they pay for their ticket, frequent flier status) rather than more efficient boarding. He points to United Airlines, which “distinguishes between members who are: Premier 1K (who preboard), Group 1 (includes Premier Platinum & Gold Members), and Group 2 (includes Premier Silver members). Groups 3-5 board relatively efficiently because they are in window, middle, and aisle seats, respectively – if they have Economy Plus or United Economy tickets. But Group 6 is for the lowest status passenger (basic economy).”

In their 2019 paper, *Lorentzian-geometry-based analysis of aeroplane boarding policies highlights “slow passengers first” as better*, the authors Sveinung Erland, Jevgenijs Kaupužs, 

The boarding process is among the top gripes of passengers, and regardless of seat allocation, can be chaotic

Markus Winger on Unsplash



Searching for **energy** efficiencies

Aircraft boarding can often be a chaotic and painful experience for passengers. For airlines, delays can result in lengthy turnaround times at best and, at worst, a litany of unintended consequences.

Alex Preston looks at some of the attempts to improve the process for the convenience of all



Vidar Frette, Rami Pugatch, and Eitan Bachmat considered the boarding process from the time when the passengers queued up in the jet bridge outside the aircraft entrance until the last passenger is seated.

The paper notes that most passengers wait most of the time during boarding since the other passengers block them from reaching their designated seats. The queue order is assumed to be maintained throughout the process, i.e., passengers cannot pass other passengers in front of them in the aisle, with boarding viewed as an iterative two-step process. First, all passengers move until they reach their designated row or until they are blocked on the way to their seats by other passengers.

Milne expounds upon these challenges, pointing out that “passengers are standing in queue (or moving slowly) because they are waiting for the person in front of them to get out of the way. It could be someone slow in front of them. More often, someone in front of them is trying to store their luggage in an overhead bin or looking for an overhead bin with enough space available for their bags. Sometimes this is called ‘aisle interference’ because it refers to passengers waiting in the aisle,” he explains.

A second bottleneck is a passenger with an aisle seat who sits down before a later-boarding passenger with a window or middle seat in the same row, on the same side of the aircraft. “That aisle seat passenger must leave the seat so the window or middle seat passenger can sit down. Sometimes this is called “seat interference” because the delay stems from the need for people to get up from their seats,” says Milne.

WILMA takes a seat

“The recent United Airlines change to their boarding method avoids this problem for boarding groups three-five because those three groups have the window seat passengers board before the middle seat passengers and before the aisle seat passengers. Of course,

their prioritisation by passenger status (preboard, groups one, two, and six) can lead to seat interferences. e.g. A high-status passenger has an aisle seat and thus boards and sits before groups three and four,” he adds.

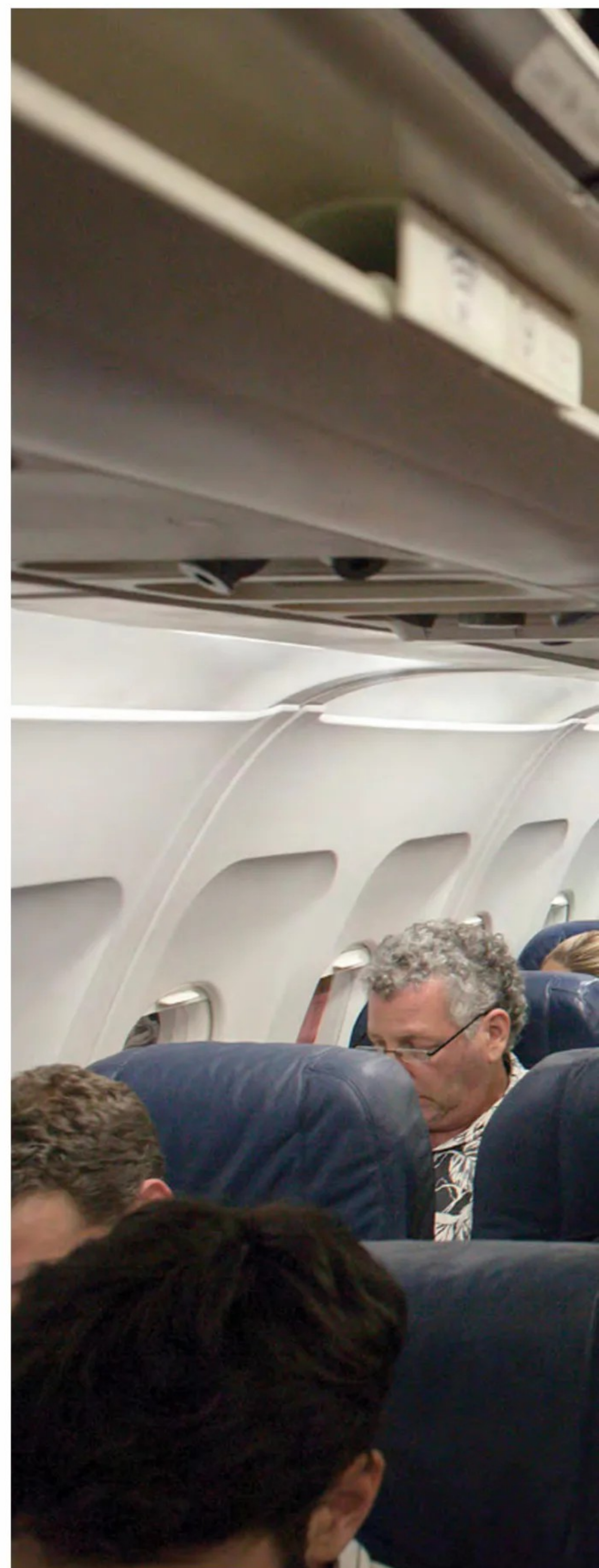
In October, United Airlines reintroduced WILMA (window, middle, aisle) boarding, claiming it had been improved to save up to two minutes of boarding time and higher Net Promoter Scores.

As a United spokesperson explains: “Boarding an aircraft using a window, middle, aisle process has proven to be the most efficient process. When we introduced our carry-on restricted Basic Economy (BE) product, we were limited to a five-boarding group structure and, therefore, had to condense the middle and aisle into group four to make space for BE. Now that we have more technical flexibility to add an additional boarding group, we’re excited to bring WILMA back to provide a smoother window, middle, and aisle boarding process flow that helps get passengers in their seats faster and saves precious time during our boarding process.”

Under the new process, United’s preboarding (including passengers with disabilities and unaccompanied minors, active-duty military, Global Services members, families travelling with children two and under and Premier 1K members, Group One (United Polaris Business, United First, United Business, Premier Platinum, Premier Gold and Star Alliance Gold), Group One (Premier Silver, Star Alliance Silver, Chase United credit card members, specific international card holders, and paid Premier Access) through to Group Three (window seats and exit rows seat) remains the same.

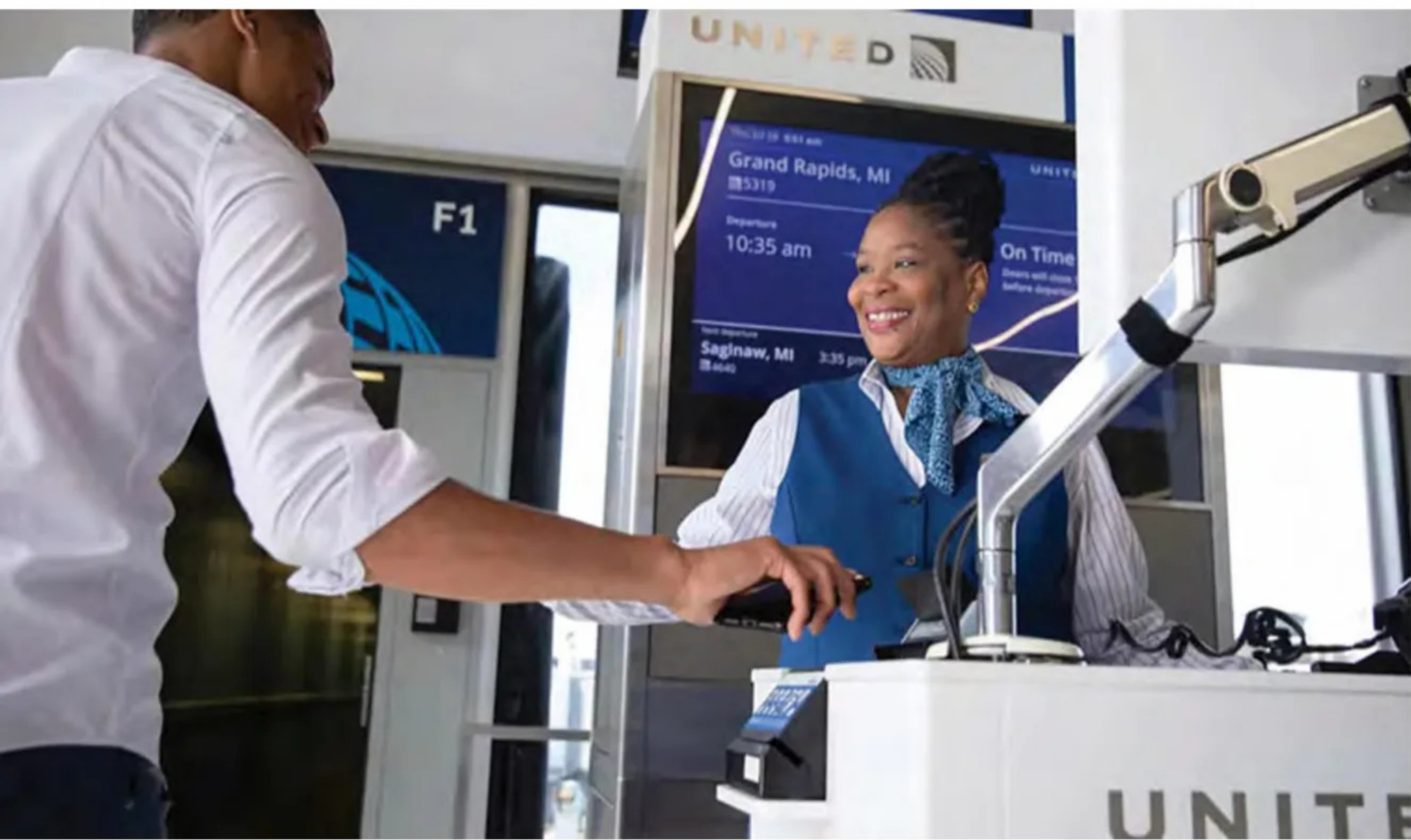
Revisions have been made to Group 4 (middle seats) and Group Five 5 (aisle seats), and a new Group Six (carry-on restricted BE passengers and those who don’t have a boarding group number on their boarding pass) has been introduced.

WILMA boarding was tested at four domestic line stations and one hub. According to the spokesperson:



ABOVE:
‘Aisle interference’ is a common sight as passengers wait in the aisle to take their seats
Chris Brignola on UnSplash

RIGHT:
United has recently enhanced its boarding process, reintroducing WILMA to speed up boarding times
United Airlines



“During extensive field testing earlier this year, the WILMA process saved up to two minutes in boarding duration. We expect this time saving will positively impact operational performance.”

But Milne believes there is a better way than what United is doing for boarding groups of three to five. “And it is easy to implement,” he says.

A new approach

“It is called the Reverse Pyramid. Instead of those three boarding groups of passengers (one each for those with windows, middle, and aisle seats), with Reverse Pyramid, there are four boarding groups for those economy plus passengers.”

The first group contains those passengers with window seats in the back half of the aircraft. Its second group has passengers with window seats in the front half of the aircraft or middle seats in the back half. Its third group contains passengers with middle seats in the front half of the aircraft or aisle seats in the back half of the cabin, while its fourth group contains passengers with aisle seats in the front half of the aircraft.

“The Reverse Pyramid method boards faster than their WILMA approach for Economy Plus passengers, and it remains simple,” claims Milne.

In the mid-2000s, Southwest started studying how it boarded its fleet, even asking passengers what they liked and didn’t like about flying.

“It was the first qualitative time we learned they overwhelmingly prefer our open seating on board the aircraft,” says a spokesperson, “but we learned they did not like our boarding process.

That revelation led the airline to test a few boarding scenarios. In October 2007, Southwest unveiled its current boarding process, where boarding positions are determined when passengers check-in for their flight. This window now begins online 24 hours before scheduled departure.

“Since then,” says the airline spokesperson, “we’ve added some a la carte products to fit the needs of

passengers who are happy to pay for either early check-in or guaranteed first-on-board while protecting the integrity of the boarding process for others: our premium, Business Select fares guarantee an A1-A15 boarding position; our Early Bird product automatically checks in Customers 36 hours before their flight.”

Southwest has a team that continuously studies the boarding process, consistently modelling various boarding schemes to “find the fastest way to board, keeping our planes in the air, and our costs as low as possible.”

Testing times

Over the past year at Hartsfield-Jackson Atlanta International Airport, the Team has tested several elements designed to enhance the boarding process and improve the turn time.

These include a designated boarding area at the gate so that Operation Agents can organise preboard passengers and families before starting the boarding process. It is a colour-coded area that easily differentiates the space. Southwest’s Operations Agents carry out essential tasks “above the wing” in the airport, including finalising details of the weight and balance of aircraft, providing an efficient and hospitable boarding experience for passengers, and co-ordinating with other workgroups to facilitate a flight’s departure.

The trial also included digital wayfinding. Here, a threshold sign and gate area display show basic flight information and visual announcements before and during boarding. With Dynamic Stanchions, boarding stanchion elements with integrated screens inform passengers of gate information and announcements being conducted and direct them through the boarding process.

Also trialled was placing an existing Self-Service Kiosk (STK) at the gate to allow passengers to print boarding passes and bag tags.

One exciting element of the trial was the jet bridge experience. Here,



CLOCKWISE FROM ABOVE:

While overhead bins have been increased in size to accommodate more cabin luggage, items still need to be stored either by the passengers themselves or the cabin crew, further adding to boarding times

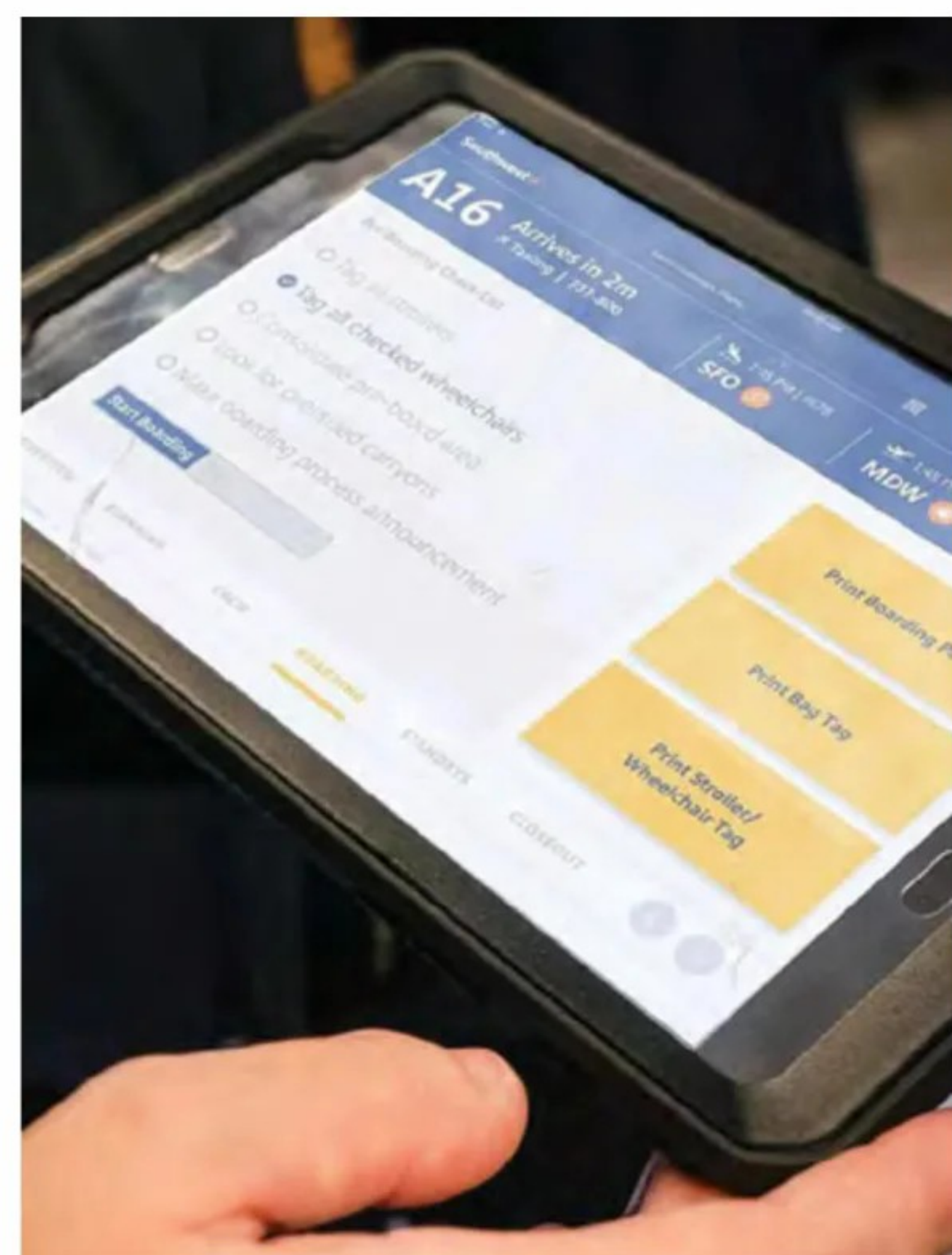
United Airlines

Southwest has moved its Operations Agents to mobile tablets to improve efficiency and communication as part of a pilot programme

Southwest

Southwest introduced boarding options for its passengers, giving flexibility without comprising turn times

Southwest



Southwest transformed the atmosphere of the jet bridge through boarding-specific messaging with seating tips, baggage tips, and passenger etiquette. Between brakes-on and brakes-off, high-tempo music will play in the jet bridge for deplaning and enplaning passengers along with pre-recorded inflight announcements.

Customer Service Agents (CSAs) are often the first Southwest employees the airline's passengers interact with during their travel experience. They extend hospitality to Southwest passengers at the ticket counter, baggage service office, and gate area.

During the trial, a tool was developed to allow CSAs to communicate with other working groups, such as Customer Service Supervisors, Operations Agents and Inflight teams, and inform passengers through visual announcements.

Critical questions for the prototype included whether more information through visual announcements reduces the lines at the CSA counters and Ops podiums. And does increased communication between working groups help the CSAs do their jobs?

Key features included providing flight information, a chat function, and the ability for CSAs to toggle visual announcements on the gate displays, threshold displays, and dynamic stanchions. There was also a printing function to print boarding passes and bag tags for passengers.

Customer Service Supervisors were also given a prototype mobile tool to proactively see risk factors for upcoming flights, monitor the status of turns in real-time, and communicate with the team at each gate.

The critical question for the prototype, which shares the same key features as the CSA tool, was: does increased communication between working groups help the CS Sups do their jobs? And does a rise in mobile device proactive behaviour decrease turn time?

The trial saw Southwest move its Operations Agents to a mobile tablet,

allowing them to communicate with other working groups, including CS Sups, CSA, Ramp, Inflight, etc.

Their workflow will reflect their future-state role and allow for roving tasks, recapturing Ops Agent downtime to prepare passengers for boarding to decrease slowdowns during the actual boarding process.

Key features include flight information, including specials, turn checklist, mobile checklist for preboarding, boarding, and closing, a mobile tool to toggle visual announcements on the gate displays, threshold displays, and dynamic stanchions, and initiating printing of boarding passes and bag tags for passengers (passes/tags will be printed at CSA desk).

The airline spokesperson said: "Based on our findings from these tests, using quantitative and qualitative data, we're exploring incorporating these elements into our operation to improve the overall boarding process and speed up the turn time."

Breaking the mould

In 2012, easyJet introduced the single most significant change undertaken in its history, with allocated seating on all of its flights.

At the time, Paul Simmons, easyJet's then-UK Director, commented: "Our customers told us allocated seating was essential to them, and the extensive trial has delivered positive feedback across Europe.

Allocated seating provides a better boarding experience and allows those passengers who want to, to choose the seat they want. Thanks to a sophisticated algorithm, passengers who do not wish to pay to select their seat will be seated with the other passengers in their booking the majority of the time."

The algorithm takes the data and seats the whole aircraft using a complex formula in less than one second. The airline trialled allocated seating in April 2012, with nearly two million passengers flying on 12,500 assigned seats. The trial started on 11 flights per day, moving

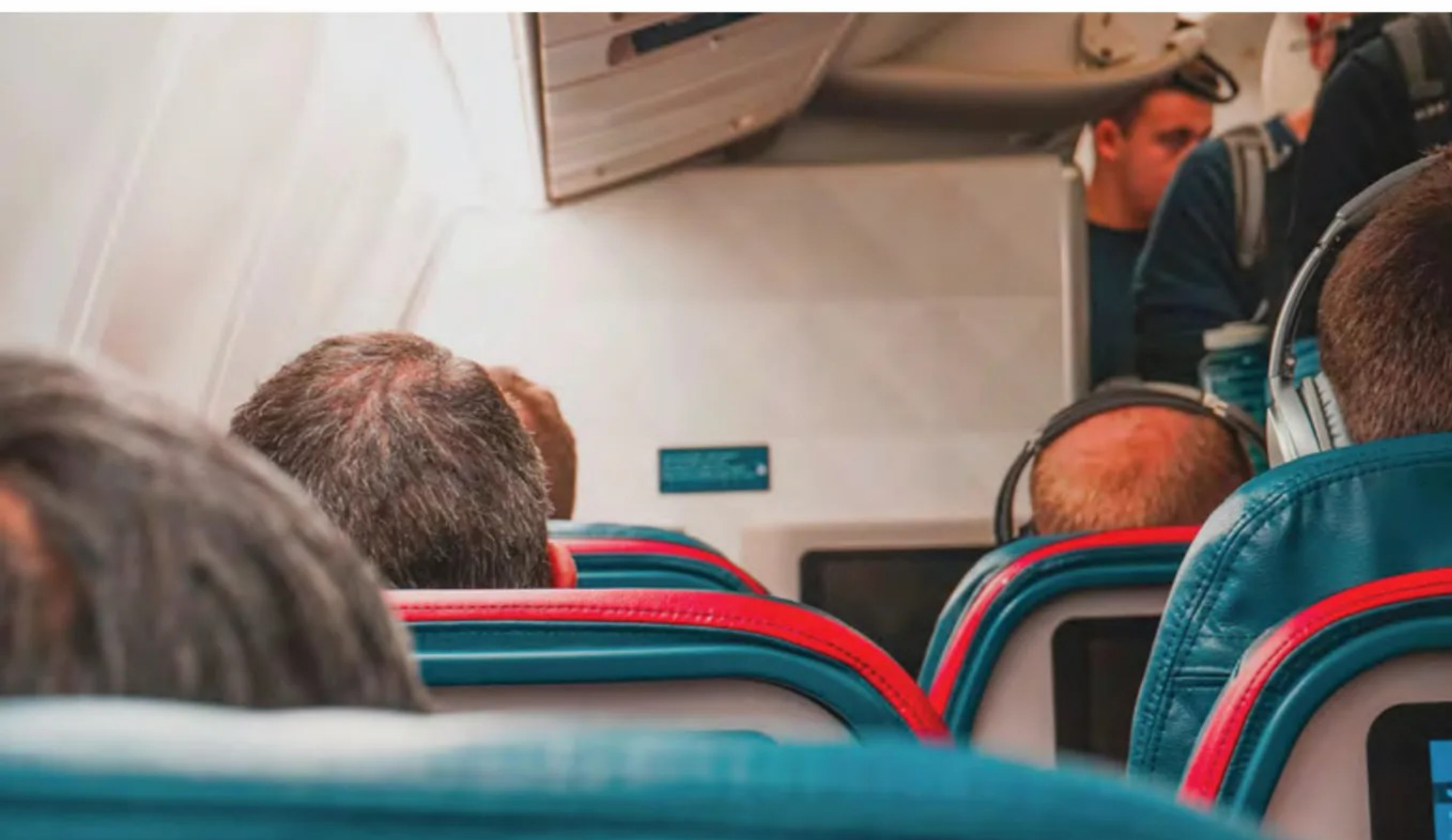


CLOCKWISE FROM ABOVE:
Music and announcements were played on the jet bridge to improve the experience for passengers
Southwest

The Southwest trial also saw the erection of dynamic stanchions, which helped passengers through boarding
Southwest

Breaking away from the traditional mould for low-cost carriers, easyJet introduced allocated seating in 2012, improving passenger ratings and revenues
easyJet

No boarding process is immune from inefficiencies or bottlenecks, but our understanding of it is helping make it more bearable for more passengers
Dylan Bueltel on Pexels



to 35, then 50 flights per day by June (approximately 5% of the network) on a representative sample of routes (leisure/business).

easyJet trialled allocated seating during the summer season, the busiest time of year, to stress test the new systems and procedures. The airline then decided to roll out the system in winter when fewer people travel to ensure a smooth transition.

Research conducted by easyJet suggested that certain customer groups, including business travellers and affluent retired people, were put off flying with easyJet due to the boarding experience associated with free seating. Allocated seating drove a 5% point improvement in customer satisfaction with the boarding experience. It contributed 0.9 percentage points to the 7.1% constant currency increase in revenue per seat in 2013 without adversely impacting turn times.

The trial flights showed that allocated seating can be delivered simultaneously while maintaining intense levels of on-time performance without adding cost. Before the trial, easyJet's reservation system did not allow for reserved seating, so easyJet added that functionality.

All passengers are allocated a seat with families and other groups travelling together on the same booking reference seated together wherever possible. Anyone who pays to select their seat is allocated it at the point of purchase. Anyone who chooses not to pay to fix their seat is given their seat number when they check in either online or at the airport.

Better by design

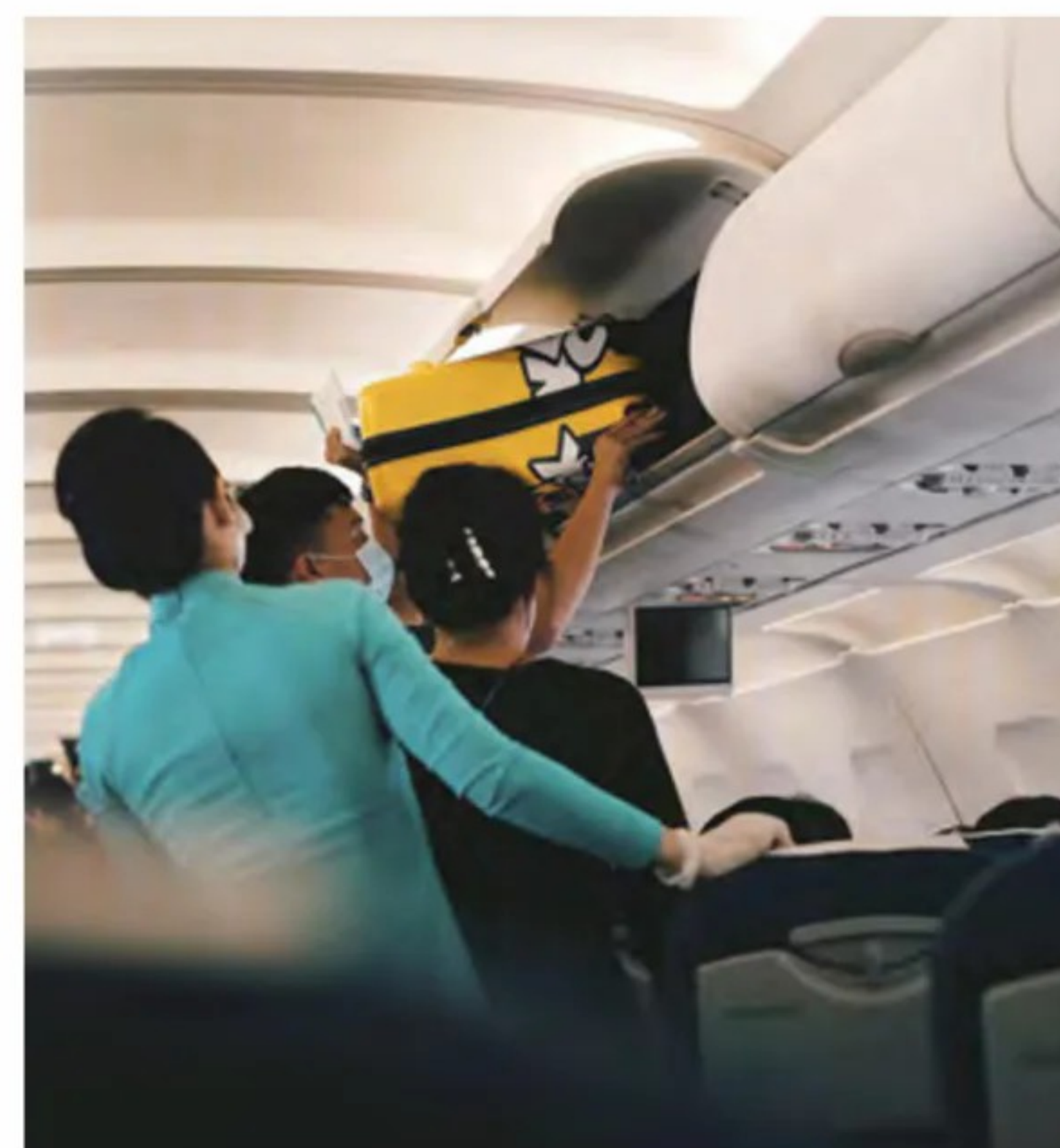
"If airlines can tolerate more complexity - and there is little evidence that they do - there are even better methods," states Milne.

"Instead of a few boarding groups, imagine a distinct boarding group for each passenger (or each family travelling together). Suppose the first few passengers to board are individuals travelling alone. The first passenger to the board has a window seat in the back row of the aircraft. The second passenger to board has a window seat

two rows in front of the back row. The third passenger to board has a window seat two rows in front of the previous passenger to board, and so on. After all window seat passengers on one side of the aircraft have boarded, all middle seat passengers board, and finally, all aisle seat passengers board in that sequence of every other row. When a family board, instead of two rows between adjacent passenger groups, there may need to be three, four, or five rows between boarding groups, depending on the number of members in a family group. This method is called the Steffen Method (after its creator, Jason Steffen)."

Milne adds that boarding time could also be reduced by assigning passengers to seats on the aircraft depending on how much luggage they carry on. "The airlines could assign passengers to seats to spread the luggage uniformly throughout the aeroplane. This would result in less time for boarding passengers to find places to store their luggage in the overhead bins. If the passengers with more luggage boarded earlier (e.g. if they have seats close to the windows), then that would also help as later boarding passengers would have an easier time finding a spot for their one carry-on than someone with two carry-ons. Of course, this would involve complexity to implement the idea."

Milne has published a paper, *A New Method for Boarding Passengers on an Airplane*, with Alexander Kelly, that incorporates these ideas. However, as Erland et al. question, their analysis shows that the boarding time with the slow-first policy is, on average, quicker than the fast-first policy. Also, some passengers prefer to spend as little time as possible in confined spaces and are very happy to be the last passenger to enter the aeroplane. However, others might dislike waiting or the idea that the "troublesome" passengers with much carry-on luggage occupy the overhead lockers, leaving little room for the coats and smaller items of the light-travelling passengers. **AI**



ABOVE FROM TOP:
Carry-on luggage, popularised by high baggage fees, is cited as a factor in delaying boarding times
Pew Ngutyen on Pexels

In recent trials, Southwest introduced designated boarding areas to see if they made preboarding more efficient
Southwest

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Eight Questions

Question 1: The commercial aviation market underwent significant changes post-COVID-19, with specific sectors no longer viable; how is AERO CARE bucking the trend?

The market has shifted. I don't think it will ever return to what it was because we now see aviation differently. For the first time in history, almost the entire industry was paralysed. At AERO CARE, market adaptability is one of the most essential qualities a company can have, aligned with supporting our airline customers.

While the market has recovered in terms of pricing (for narrow body engines in particular), we see a significant demand for CFM56-7B engines for lease, while the CFM56-5B and V2500-A5 engines have a steady market requirement. We are not dismissing older engines either, such as the CFM56-3 and CFM56-5A. Due to the manufacturing issues with the new engines [LEAPs], it is evident that older engines have an extended life, and we still consider them a good investment if the price is right.

Question 2: AERO CARE offers several services. Is there one particular sector seeing more demand than another and, if so, why?

AERO CARE is a reliable source of aircraft engines for lease, trade and disassembly.

We also specialise in APUs [Auxiliary Power Units] and airframe parts. However,

our focus is primarily on engines. We are currently experiencing demand for engines with green time remaining for lease and engine parts located at our warehouse in Miami. We always have fan blades in stock for CFM56-5B and CFM56-7B that we offer for outright sale or exchanges.

Engine maintenance is also a source of regular business. AERO CARE also manages engine repair shop visits, such as performance restorations, LLP [life-limited parts] replacement, or smaller 'hospital' workscopes and parts.

Market forces dictate that operators keep their older aircraft flying longer, and the world of aircraft engine supply, maintenance and repair is dynamic.

This is a challenge, but it is also an exciting part of the industry to be involved with.

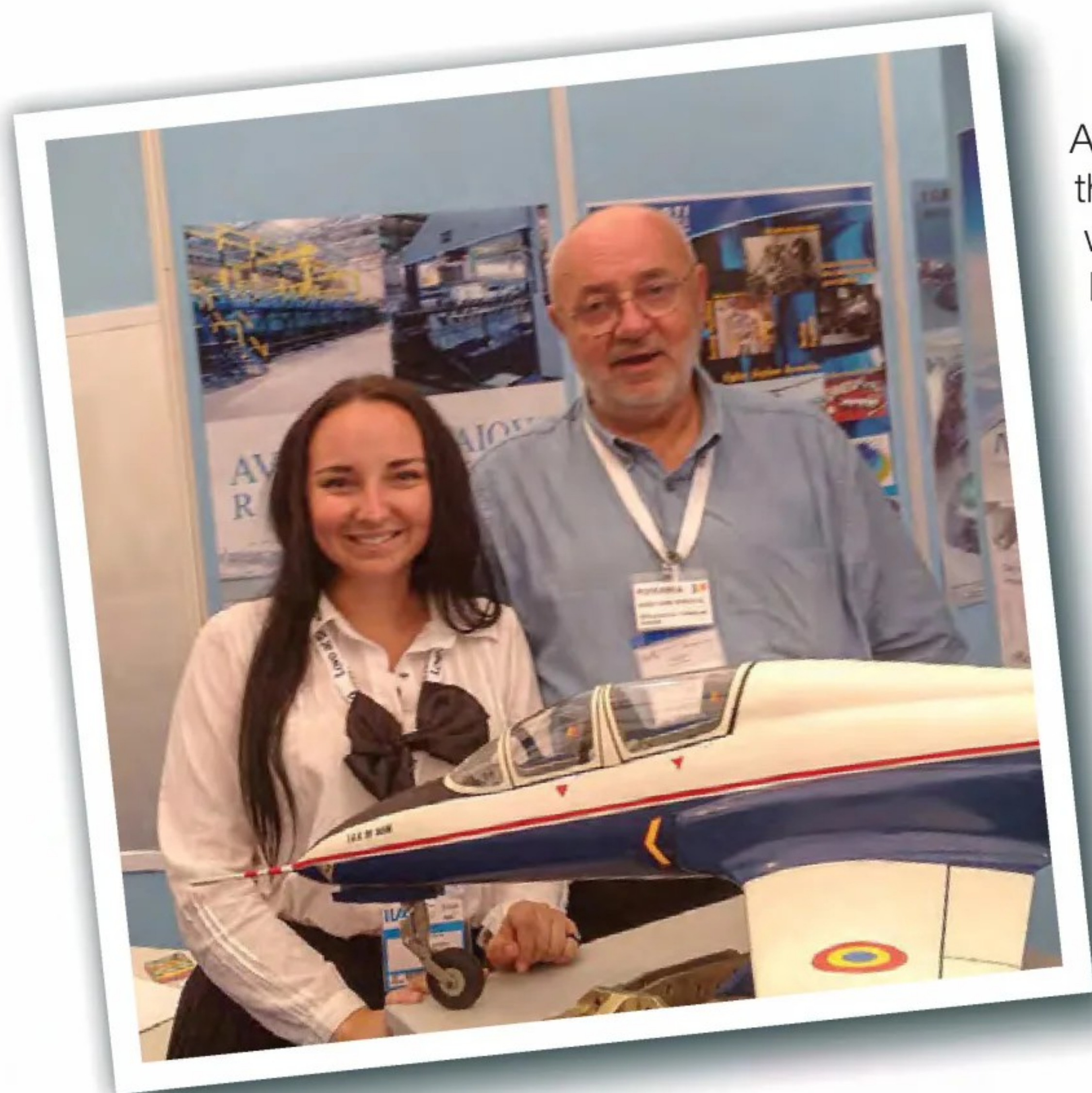
Question 3: With the commercial sector shifting to green, how is AERO CARE looking to develop its practices, and what procedures do you have in place already?

Sustainability and ESG [environmental, social and governance criteria] have moved from being a consideration to becoming an integral part of AERO CARE's decisions around strategy and how we transact. The industry has ambitious sustainability and net zero targets, and it is only through taking an active role that we can expect the



She was taught the intricacies of the aircraft industry by her late father, Cristian Mihalache, and has a life-long passion for aviation. Now, **Anca Mihalache** is the managing director of AERO CARE and is preparing to make her mark on the company that already has a respected name across Europe. She spoke to *Air International*





AERO CARE is not affected by the situation with new engines as we deal with end-of-life assets. However, the delay in delivery, both for new engines and parts, has caused the market to experience greater demand than availability on some parts. Parts distributors have been unable to fill the gap, which has exacerbated delays at the repair shops.

The main impact on AERO CARE was that the financial returns for engine parts harvested after an engine disassembly were critically delayed. This resulted in increased capital costs, leading to higher costs in general. We even had

components that stayed almost a year in the repair shop before they were returned to us for sale. Things are improving now, fortunately, but we are still not where we are supposed to be.

On the green time lease side, the supply chain issues increased the demand for these types of engines. But not many are left in the market to support the permanent demand.

But things are on the right track, so we are confident that the supply chain issues

needed to be a perfectionist. The first thing he taught me when I started working for AERO CARE, the company he founded in 2007, is that I must be the best version of myself at my job. Although he wouldn't call it a job, for him, it was his passion.

It's the same for me; I love working in aviation.

My father was very disciplined and highly organised, never missing a deadline, which is an important skill to have. I was fortunate to have had him as my mentor and father, and I am determined to ensure that AERO CARE will become a respected and well-known name in aviation.

Question 6: AERO CARE is about to open a division in the US. Why is this important regarding the demand you're seeing in the market?

AERO CARE has become part of Alchemy Aero Group, a US-based specialised aviation investment platform, to enable us to take the company to the next level. Through this relationship, I am partnering with Robert Syms, who brings extensive experience in investment banking and the capital markets. As part of Alchemy, AERO CARE will have access to the capital support we need to grow alongside our customers and ensure

industry to meet those demands successfully.

As a participant in the aftermarket, AERO CARE is empowered and positioned to influence the conversation internally and amongst our customers and suppliers. For example, AERO CARE is supporting airline sustainability through exchange programmes, while also positively influencing emissions goals by pushing more significant freight volumes through carriers focused on fleet efficiency and carbon neutrality.

Internally, AERO CARE continues to move towards a paperless environment. Our record-keeping has moved entirely to digital, and our focus on reducing energy costs has led us to co-locate our inventory in Europe and the USA. What is more, we are seeing both operational and financial benefits to pursuing a greener course. This only serves to encourage us to continue pushing further.

Question 4: Engine manufacturers have raised the issue of supply chain issues following the pandemic, with many still stating that things have not entirely returned to normal. Have you found this to be the case and, if so, what has been the impact on AERO CARE?



will eventually be resolved, reducing lead times by 2025.

Question 5: You have taken over the company from your late father; what did he teach you were the 'golden rules' to follow within the aviation industry to ensure AERO CARE remains one of the best?

My father was an excellent aircraft engineer and extremely passionate about aviation. He loved his job and dedicated much of his life to it. I have grown up in this spirit, flying regularly since I was a little girl, and I used to go with him to air shows from a young age.

He used to approve aircraft for take-off while working for various airlines, so he

long-term success.

Opening an American entity allows us to respond quickly in two different time zones, and having our stock located in Miami, close to the airport, means we can react promptly to AOG [aircraft on the ground] situations.

AERO CARE always focuses on providing our customers with a best-in-class service. Having trans-continental operations gives us enhanced capabilities to provide customers with peace of mind in what can be a frenetic industry.

Question 7: A predicted shortage of skilled personnel is coming within the engine sector, which may impact the industry. Have you seen signs of



this and, if so, what precautions does AERO CARE have in place?

We consider that the best way for AERO CARE to be prepared for the shortage of skilled people is to build our inventory of the engine parts that the industry needs. The lack of technicians at manufacturers and repair shops will continue to affect the supply chain until enough new people are trained or repair processes are further automated.

So, we need to have enough stock to sell and exchange, thus maintaining a revolving inventory. This is why, at AERO CARE, we are looking to buy packages of engine parts as well as entire engines that are candidates for disassembly and then

parting-out into spares. We plan to be able to support our airline customers with various programmes, like the supply of engine fan blades, which is why we need to have multiple sets available.

Question 8: How do you spend your free time away from aviation?

I enjoy doing Zumba; cardio exercise to loud music gives me a lot of energy. Of course, working in aviation is a given. I love travelling, and my favourite country is Italy, where spending time in cities with so much history to tell is fascinating. I also enjoy the sea, going out on a boat, relaxing under the sun, and reading a good book. **AI**

TOP LEFT:
Anca with her late father, Cristian, at a trade show. It was at these events she learned the intricacies of the aviation industry
AERO CARE

BELOW:
Keen to extend the reach of the company within the next few years, Anca has had many online meetings with new clients
AERO CARE



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Glenn Sands Editor

Mark Broadbent
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**Sally Hooton, Suzanne Roberts,
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Andrew Mason Commercial Sales Manager,
Commercial and Military
andrew.mason@keypublishing.com
Calum Handley
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Suzanne Taylor
Head of Sales and Marketing
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Publisher

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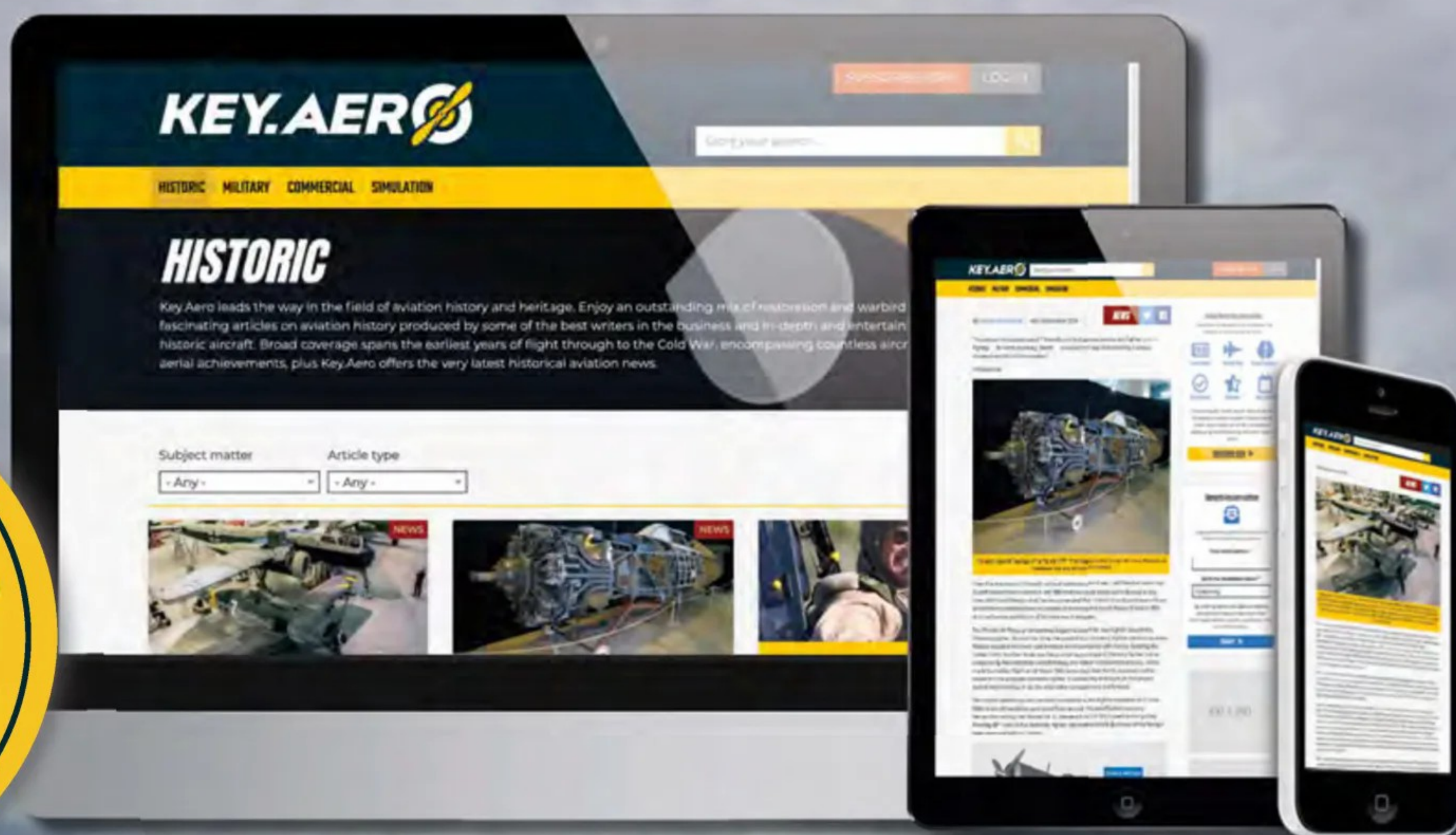
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